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SYSTEMS AND FEASIBILITY TRADEOFF ANALYSES.

TASK 1. ~~REPORT (CDRL A001)~~

ANALYSIS OF CURRENT AND PROPOSED TECHNICAL MANUAL SYSTEMS.

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

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DAVID W. TAYLOR, NAVAL SHIP R&D CENTER (CODE 186A)

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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

This Task 1 report documents the source information, the analyses, and the findings for the first of seven tasks in Phase I, Systems and Feasibility Tradeoff Analyses (SFTOA) within the Navy Technical Information Presentation Program (NTIPP) under the above-cited contract number.

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Item 19 Continued:

content capture
content distribution
content generation
content replication
contract data requirements list (CDRL)
data acquisition
data item description (DID)
digital assembly parts identification lists (DAPIL)
engineering change notice (ECN)
engineering change proposal (ECP)
feature of effectiveness (FOE)
feedback
fully proceduralized job performance aid (FPJPA)
fully proceduralized trouble-shooting aid (FPTA)
functionally oriented maintenance manual (FOMM)
human-readable/machine-readable (HRMR)
illustrated parts breakdown (IPB)
improved technical documentation and training (ITDT)
in-process review (IPR)
integrated logistic support (ILS)
integration
job performance aid (JPA)
job performance manual (JPM)
life cycle cost(s) LCC)
logistic support analysis (LSA)
maintenance allocation chart (MAC)
maintenance and operating technical data (MOTD)
maintenance dependency chart (MDC)
maintenance information automated retrieval system (MIARS)
maintenance parts list (MPL)
maintenance requirements card (MRC)
measure of effectiveness (MOE)
navy technical information presentation program (NTIPP)
navy technical manual system (NTMS)
optical character recognition (OCR)
planned maintenance system (PMS)
printing resources and management information system (PRMIS)
quick reaction technical manual modification system (QRTMMS)
reading grade level (RGL)
reading impact difficulty estimate (RIDE)
ship technical data management information system/ship technical publications system (STEDMIS/STEPS)
systems and feasibility tradeoff analyses (SFTOA)
technical manual (TM)
technical manual contract requirements (TMCR)
technical manual deficiency evaluation report (TMDER)
technical manual identification numbering system (TMINS)
technical manual improvement program (TMIP)
technical manual management program (TMMP)
technical order (TO)
technical order improvement reporting system (TOIRS)
technical order microfilm system (TOMS)
technical review and update of manuals and publications (TRUMP)
unsatisfactory report (UR)
update
user-data match
work package (WP)

Item 20 Continued:

The technical approach to Task 1 involved the application of systems engineering methodology to the research effort. Nine Research Issues were formulated which served as focal points for the effort. The report body is organized around these Research Issues; each is defined and its objective set forth, followed by the analysis of U.S. Navy technical manual operations (current and proposed) pertinent to that Issue. For purposes of broad comparison, technical manual operations of the U.S. Army and Air Force, and of analogous operations of other Governmental and civilian organizations, were also examined and are documented herein.

Item 20 Continued:

(of task 1

Principal conclusions and recommendations (of task 1) include: the present inability to adequately compare technical manuals from NAVAIR, NAVSEA, and NAVELEX due to differing utilizations, environments, and repair and maintenance philosophies; the lack of standardization in present funding of technical manuals (some are by budget processes, others by Navy Industrial Funding, etc); the need for technical manuals to include coverage of repair and replacement actions below the predetermined replacement level, to accommodate wartime and other conditions when replacement-level spares may be unavailable; the need for the means of funding the aforementioned coverage increment below the replacement level; and the need for a Media Evaluation Laboratory to codify the characteristics, benefits, and transformation parameters of the various media available for use in the technical manual process.

SYSTEMS AND FEASIBILITY TRADEOFF ANALYSES

Task 1 Report (CDRL A001)
Analysis of Current and Proposed
Technical Manual Systems

Submitted to
David W. Taylor
Naval Ship R&D Center (Code 186A)

by

Hughes Aircraft Company
Ground Systems Group
Fullerton, California

24 March 1977
FR 77-12-332
Contract No. N00600-76-C-1352

FOREWORD

Hughes Ground Systems Group is pleased to submit this Task 1 Report, identified as CDRL Item A001, to the David W. Taylor Naval Ship Research and Development Center (DTNSRDC), Bethesda, Maryland in accordance with Contract N00600-76-C-1352 for the Navy Technical Information Presentation Program (NTIPP). This contract is under the technical management of Mr. R. A. Sulit and Mr. J. J. Fuller, both of DTNSRDC Code 186A.

Task 1 is the first of seven contractual tasks in NTIPP Phase I -- Systems and Feasibility Tradeoff Analyses. The purpose of Task 1 is to establish a data base which codifies the features and capabilities of current and proposed technical manual systems. This data base, in turn, serves as the foundation for synthesizing the functional requirements of Task 2 and identifying potential alternatives for the baseline design process of Task 3.

Performing organization personnel who participated in the Task 1 effort and with the preparation of this report include the following individuals, with principal investigators identified by asterisk:

J. E. Connell (Program Manager)
D. W. Gater
J. W. Kelsey
*R. J. Kennihan (User-Data Match)
*A. Laicato (Content Generation, Update, and Integration)
*C. E. Marvin (Data Acquisition)
H. A. McDougal
*R. C. Sisman (Content Capture and Replication)
*W. L. Taylor (Distribution and Feedback)
D. R. Wilkins
W. F. Ziegler

EXECUTIVE SUMMARY

Section - Executive Summary

1 PROBLEM ADDRESSED BY THE TASK 1 EFFORT

Navy recognition of technical manual shortcomings has led to the establishment of the Navy Technical Information Presentation Program (NTIPP). This program is tasked with studying and analyzing the Navy's current and proposed technical manual systems, and with formulating improvements which are to result in effective, user-matched technical manuals in the 1980s.

NTIPP consists of four phases: Phase I - Systems and Feasibility Tradeoff Analyses (SFTOA); Phase II - System Design, Pilot Testing and Prototype Specifications Development; Phase III - Prototype Development and Test; and Phase IV - Prototype Operation and Production Specifications Development. This report documents Task 1, Analysis of Current and Proposed Technical Manual Systems, which is the first of seven SFTOA tasks in Phase I.

Numerous surveys and analyses of technical manual effectiveness have concluded that present-day technical manuals exhibit a wide range of faults. Principal among these are that manuals are not matched with the using technician's background nor with his working environment; inadequacies in coverage and content escalate the technician's task time in maintenance, fault isolation, troubleshooting, repair, and replacement; manuals are frequently outdated or nonexistent in the user's work environment; manuals are not effective as training aids, etc.

These faults manifest a collective trait - insufficient priority to the characteristics and needs of the user - which cuts across the entire technical manual process. Previous attempts to remedy technical manual shortcomings by treating piecemeal symptoms of the problem have fallen short of their goal, leading to the conclusion that the overall problem can only be solved through the simultaneous application of user-oriented emphasis to all steps in the technical manual process.

This process includes the traditional tasks of technical manual procurement and acquisition, content generation, content capture and replication, distribution, update, and user feedback. In addition, two new steps must be added.

First, to establish a user-oriented approach at the inception of the technical manual process, an analytical human factors study must be performed to achieve and maintain compatibility between technical manual design and the array of anticipated users and environments. This has been termed the "user-data match" in Task 1, and involves such concerns as optimized formats, reading and comprehension levels, information presentation techniques, and physical use factors in the user's environment.

Second, in the interests of a cohesive technical manual system which safeguards and promotes the user-oriented priority throughout the entire process, an integration function must exist which serves to monitor the remaining steps and assure the smooth flow of operations from initial planning to technical manual use.

The role of Task 1 in addressing this problem is to establish an information base describing the current and proposed technical manual systems of the Navy, analyze the deficiencies and adequacies of those systems, and to serve as a basis for the subsequent tasks of requirements delineation and preliminary baseline definition which are the subjects of Tasks 2 and 3, respectively.

2 APPROACH TO TASK 1

The approach to Task 1 was characterized by the application of systems engineering methodology to the research effort, allocation of specific preplanned resources, principal emphasis on U.S. Navy technical manual operations, and limited coverage of non-Navy activities for comparison.

Much of the technical approach to Task 1 results directly from the application of key tools from the systems engineering discipline. The structure of Task 1 is that of a comparative system analysis; this required that a set of evaluation criteria be first established, and then used as a reference model against which the features of current and proposed technical manual systems were compared. The results of this comparative analysis are not to be construed as critical, but rather as preliminary guidelines which serve to initiate the subsequent baseline approach which will culminate in a complete system design at the close of Phase I of NTIPP. The purpose of using system engineering tools in a research activity such as NTIPP is to maximize the probability of including all significant issues and to process them in convergent fashion - i.e., the evolving design neither becomes "open-loop" nor ignores useful options.

Another outgrowth of applying systems engineering methodology to the Task 1 effort was the formulation of nine discrete Research Issues around which the work was focused. Within the body of this report, analyses of current and proposed technical manual systems of the Navy and others are organized by Research Issue for clarity of presentation.

To assure convergent design throughout Phase I, the results of Task 1 are constrained in advance by the need to be suitable information bases for Task 2, Establishment of NTIPP Requirements, and Task 3, Development of Preliminary NTIPP Concept and Alternative Configurations. These latter tasks begin the familiar systems engineering baselining process, and the role of Task 1 is to properly support the initiation of that process.

It should be noted that Tasks 1 and 2 were performed within the same seven-month timeframe because of the close correlation required. A total of some 75 man-months were devoted to the combined effort, of which about 55 are attributable to Task 1 and 20 to Task 2.

In conducting the analysis of current and proposed technical manual systems, it was necessary to establish operating definitions of "current" and "proposed." For clear demarcation, current systems and techniques are defined as those which are now in widespread use, or have had significant impact on the fleet. Proposed systems and techniques, then, are defined as those which have not yet achieved this status of usage or impact, even though their planning and approval may be complete and their implementation begun. Discussion and full credit for such "currently proposed" items are given in the "proposed systems" sections within this report.

Although principal coverage was allotted to technical manual systems of the U.S. Navy, the Task 1 efforts were not restricted to Navy operations; similar technical manual operations of the U.S. Army and Air Force, and of selected nonmilitary government agencies and commercial firms, were also investigated to provide an additional basis for broad comparison. However, these non-Navy operations did not receive the same in-depth treatment as did those of Navy organizations.

3 CONCLUSIONS AND RECOMMENDATIONS OF TASK 1

The principal conclusions and recommendations from Task 1 involve the need for measures of technical manual system performance, the establishment and/or standardization of cost collection and funding mechanisms, extension of technical manual coverage below the replaceable-item level, and the creation of a Media Evaluation Laboratory.

Recognizing that the primary purpose of Task 1 is to provide the foundation for establishing NTIPP design requirements and constraints, care must be taken to avoid drawing conclusions and recommendations which could bias or prejudge the subsequent development of the baseline and alternative approaches. The following paragraphs offer substantive findings which fall within those bounds.

Present Navy Status - By comparison with the U.S. Army and Air Force, and with the other organizations examined, the Navy technical manual system appears to stand in good stead. By virtue of the conduct of NTIPP, the Navy is the only service now concerned with a unified approach to improving technical manuals in all respects, rather than seeking piecemeal "cure-all" approaches to separate parts of the problem.

Comparison of Manuals from Different SYSCOMs - The natural tendency to draw comparisons among technical manuals issued by NAVAIR, NAVSEA, AND NAVELEX is hampered by extensive differences in maintenance philosophy and approach which impact technical manual utilization. NAVAIR, for example, employs a discrete distinction between the flight line, intermediate and NARF levels of maintenance. NAVSEA and NAVELEX, however, are effectively prohibited from utilizing this distinction due to the essentially noncomparable nature of ships as weapon platforms, as opposed to aircraft. On the other hand, NAVSEA and NAVELEX must follow a "repair-in-place" philosophy due to the inherent nature of equipment installations, using test equipment which is brought to the equipment location; NAVAIR instead sends the faulty equipment to the repair shop. These differences effectively obviate meaningful comparison between the types of technical manual products now produced by the various SYSCOMs.

Technical Manual System Performance Measures - To resolve the noncomparability situation just described, and to provide a future means for judging the effectiveness of a technical manual system as well as of technical manuals per se, it is obvious that one or more measures of performance must be established. This matter will fall within the responsibility of the NTIPP Integration Research Issue in subsequent tasks.

Extension of Technical Manual Coverage - A key conclusion from the Task 1 effort is that maintenance technicians have a clear need for technical manual coverage involving troubleshooting, repair, and replacement activities below the replaceable-item level defined by the maintenance philosophy for a given equipment. The realities of fleet deployment in the case of wartime and other emergency conditions raise the need for repair of replaceable items when such items are not available as spares for replacement. This repair cannot be properly performed without adequate data which is available to the technician, presumably with the admonition that such repair not be effected except in cases of emergency. It is recommended that this area be closely considered by the Navy, for potential inclusion in future technical manual requirements.

Funding for Extended Technical Manual Coverage - Some means must be found for funding the data increment described above. It is recommended that this additional cost be accommodated on the grounds that the increment is a surcharge for wartime readiness, over and above the costs for supporting the equipment in nonemergency conditions.

Differences in Technical Manual Funding - Task 1 findings have included the determination that technical manual organizations within the SYSCOMs are funded by differing means. Some are funded by budget processes, while others are supported by Navy Industrial Funding. As this distinction offers a significant potential impact on cost criteria (a key constraint in Task 3 of NTIPP Phase I), it is felt by the contractor that NAVMAT guidance is needed to clarify this issue so as to avoid biasing the preliminary baseline formulation in Task 3 and the cost/effectiveness analyses of Task 5.

Establishment of a Media Laboratory - The considerable variations in impact of media available to the technical manual process deserve detailed analysis to determine the full merits of the various media for differing applications. This concern is escalated when information is transformed from one medium to another (eg, paper to microform or electronic storage) since the user comforts in one do not necessarily transfer to the other. It is recommended that the Navy establish a Media Evaluation Laboratory to analytically investigate these matters, to avoid requiring the fleet to make such determinations by necessity.

Standardization vs. Tailoring - A lack of standardization is exhibited in technical manual operations due to divergences in approach by the various SYSCOMs. Although standardization may instinctively appear to be a reasonable goal in all cases, it should be recognized that some deliberate "tailorings" of approach may be necessary in the interest of cost/effectiveness to account for occasional uniquenesses in technical manual applications among the SYSCOMs. The concern in this regard is that neither the present divergences nor the present commonalities among the SYSCOMs' technical manual operations have been demonstrated analytically on the basis of cost/effectiveness; this task remains to be accomplished before determining the extent of deliberate tailorings.

Standardization is already being stressed on an intra-SYSCOM basis, eg, through NAVSEAINST 5600.7 and 5600.8. It should also be noted that some standardization has occurred among the SYSCOMs, eg, numbering systems for technical manuals, and that at least one SYSCOM (NAVAIR) has recommended centralizing the technical manual system authority on a Navy-wide basis.[1]

[1] Faulders, RADM C.T., Jr., NAVAIR Ltr AIR-OA4:FMM:cse/228 of 12 Nov 1976, Subj: "Standardization of the Navy Technical Documentation System, recommendations concerning."

3 CONCLUSIONS AND RECOMMENDATIONS OF TASK 1 (Continued)

Contractor Attitudes - In general, private contractors have been found to be insufficiently responsive to the Navy's technical manual problems, either from a lack of understanding of these problems or from an unwillingness to address them for economic reasons. This is consistent with the REM Company's findings, which suggest that ". . .approximately half of all contractors have no real interest or desire in improving technical manuals."[1]

Training Factors - One of the responsibilities of NTIPP is to improve the degree of influence by the training community on technical manual design, since the manuals are often used as texts or supplementary training materials in formal schools and on-the-job training environments. At present, this influence is virtually nonexistent, and proposals for improvement are sparse. Substantive recommendations for implementing such influence are to be found chiefly in the draft report of a research effort paralleling the NTIPP Task 1 reporting period.[2]

Findings in the Research Issue Areas - As previously stated, the body of this report is organized around the nine Research Issues which served as focal points for the research. The following table summarizes the individual findings in each of the Research Issues.

[1] Martin, A. C. and Johnson, F., "A Critical Evaluation of the Technical Data Development Processes for the Preparation of Technical Manuals and Training for Maintenance, Task Report 4: Critical Evaluation," REM Company, August 1975.

[2] Braby, Richard, "Summary of (Training) Issues and Tentative Recommendations," Draft Issue, Training Analysis and Evaluation Group (TAEG), Orlando, Florida, December 1976.

TABLE E-I. SUMMARY OF TASK 1 FINDINGS BY RESEARCH ISSUE

Research Issue	Findings
1 User-Data Match	Previous attempts have been largely of piecemeal nature,* with total cure expected through treating part of problem, eg, by use of new format...lack of all-encompassing approach addressing all symptoms simultaneously to establish effective match between ultimate user and his technical manuals
2 Data Acquisition	Instructions and procedures vary by SYSCOM...separate TM-related programs (eg, MIARS, TRUMP/ADPREP, STEDMIS) not well coordinated...specifications inadequate and inflexible in steering content...specifications include insufficient samples of text, illustrations and tables...few specifications provide for adapting TM data to user needs...some do not tie TM data to a maintenance plan
3 Content Generation	Data base developed for engineering/manufacturing purposes only, often incompatible with MOTD generation...TM preparation schedules based on design engineering data release, but TM deliveries not slipped if such data is late...bookplans/outlines often required 60 days after contract award, but of doubtful value due to the preliminary nature of engineering design data at that time
4 Content Capture	Technology basically adequate, except for graphics input to automated systems...divergent SYSCOM implementation approaches involving media and hardware...absences of Navy-wide standards...not a pacing item...can keep up with other developments
5 Content Replication	Technology basically adequate...major decision to be made is the selection of delivery-oriented media...future changes to be based on conversion to all-digital form, on-demand replication needs, and extent to which paper becomes a secondary medium
6 Distribution	Present conduct reasonably adequate...future role change involves placement and contacts closer to user, both for feedback and for on-demand replication...all-digital nature must be allowed for

*Notable exception is NAVAIR's Work Package concept which combines task analysis, microform compatibility, and functionally organized format; job task analysis is important element both of user-date match and data acquisition and content generation which implement its findings

3 CONCLUSIONS AND RECOMMENDATIONS OF TASK 1 (Continued)

TABLE E-I. SUMMARY OF TASK 1 FINDINGS BY RESEARCH ISSUE (Continued)

Research Issue	Findings
7 Feedback	Inadequate at present...TM feedback function needs dedicated system such as NAVAIR's new Data UR's, rather than inclusion in equipment-oriented feedback system... potentially, use distribution system in reverse... coordinate with Integration to assure corrective action
8 Update	Largely handled in same fashion as new TMs, except for trends toward in-Navy handling in future...potential impact on continuity of content generation if so handled in Navy
9 Integration	Relative absence of current/proposed provisions in technical manual systems studied...better definition needed of external interfaces between technical manual organization, logistics activities, and peer functions such as training and provisioning...lack of standardization in cost-collecting procedures and formats...lack of means for technical manual performance evaluation

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SECTION 1
INTRODUCTION

Section 1 - Introduction

1.1 - OBJECTIVE

The objective of Task 1 is to establish a data base from which subsequent tasks can proceed. As such, the results of Task 1 must be suitable for derivation of preliminary NTIPP requirements and for the synthesis of viable NTIPP alternatives.

Task 1, Analysis of Current and Proposed Technical Manual Systems, is the initial effort in the seven-task structure of NTIPP Phase I - Systems and Feasibility and Tradeoff Analyses (SFTOA). Task 1 has two distinct objectives:

(a) To establish a documented base of information, with analytical conclusions, from which preliminary NTIPP requirements can be synthesized in Task 2, and

(b) To form the information base from which viable NTIPP alternatives, in whole or in part, can be formulated for comparison and preliminary selection in Task 3.

The Task 2 requirements and the Task 3 alternatives will be derived from the same data base - namely, the output of Task 1, as represented by this report. Hence, this output must be amenable for both purposes.

The intent in analyzing current technical manual systems is to establish a firm definition of present operations by technical manual organizations in the U.S. Navy and elsewhere. From this definition, gaps and inadequacies can be identified in the analysis; conversely, those areas whose operation adequately fulfills present needs are identified as well. Any shortcomings so identified represent needs which must be addressed by proposed improvements and subsequent system requirements.

The existence and impact of currently conceived improvements, as identified in the analysis of proposed technical manual systems, serve both to indicate the feasibility of satisfying desirable requirements and to indicate the relative direction to be taken by alternatives which are deemed viable - ie, they at least satisfy the minimal requirements. Moreover, to the extent that proposed improvements so identified do not satisfy the shortcomings of current technical manual systems (as determined in that analysis) this highlights the areas for which new solutions must be formulated.

In addition to the analysis of current and proposed technical manual systems in the U.S. Navy, Task 1 is concerned with the analogous status of other Services and nonmilitary organizations as well. For example, Army and Air Force technical manual systems possess many features of overall similarity to the Navy system, and techniques employed therein may be useful for comparison. Certain operations of nonmilitary Government agencies and of commercial contractors may also be comparable to portions of the Navy technical manual system, and hence are to be examined during Task 1.

1.2.1 NATURE OF THE TRADITIONAL TECHNICAL MANUAL PROBLEM

The traditional complaints involving technical manuals collectively point to the need for a unified, user-oriented approach to the entire technical manual process. By meeting the needs of the maintenance technician as the ultimate user, technician task time may be reduced from its present level.

Technical manuals are those documents which are used by the technician as primary references in troubleshooting/repair and routine maintenance, and often as instructional aids during formal technical training. Kinds of information in technical manuals include equipment descriptions, theory of operation, operator's instructions, planned maintenance actions, fault isolation and troubleshooting procedures, disassembly/repair/replacement instructions, and part-number information to assist in ordering replacement components.

The process by which technical manuals come into existence results from the Logistic Support Analysis (LSA) activities which are part of the procurement cycle for the hardware system or component served by the manual. Based on LSA results, technical manual needs are defined and specifications levied on the preparation effort; content is generated, compliant with the specifications, from available engineering/manufacturing data bases; content is reviewed and approved by the procuring agency; and the manual is published and distributed to its users - usually, shipboard or shore-based maintenance technicians, although use is also made of the technical manual as a training aid in technician training schools. Subsequent changes deemed necessary due to equipment modifications or errors in the manual follow substantially the same process, though often on a delayed basis, and the user has an opportunity to feed back comments, suggestions, and complaints.

The role of the technical manual in repair and maintenance operations is one of assisting the technician in maximizing equipment availability through preventive maintenance, and in returning the equipment to operation as rapidly as possible after malfunctions occur. A wide range of technician time may be expended or saved, depending upon the technician's ability to efficiently locate and use the information he needs for his various maintenance operations.

The training role of the technical manual is one of assisting the student technician to learn the function of the equipment and to become familiar with maintaining/repairing that equipment. Here, effectiveness is based upon the ease with which the student learns, using the manual as a textbook or secondary reference.

Numerous surveys and analyses of technical manual effectiveness have concluded that present-day technical manuals exhibit a wide range of faults, of which the more common are summarized in Table 1-I. Manuals are not matched with the technician's background nor with his working environment; the procurement and distribution system falls short in providing and maintaining all of the manuals the technician needs, and keeping them in an up-to-date condition; manuals are not effective as training aids; etc.

However, the most pronounced shortcomings become manifest when the technician attempts to use his manual for fault isolation, detailed troubleshooting, repair, and replacement. If the observed equipment malfunctions are not covered in the troubleshooting procedures (a common occurrence), the technician must locate the fault by tracing electrical signals or mechanical motion across a variety of schematics, flow diagrams, etc. Difficulties in tracing this route - due to absences of cross-references between diagrams and inconsistencies in nomenclature and abbreviations - add greatly to his search time. Often, system-level flow and/or coverage of key interfaces may be missing altogether. Finally, after locating the faulty component, he may have to conduct additional searches for the necessary part-number information - National Stock Number, manufacturer's part number, etc. - before he can order a replacement. A recent technical manual user's survey by the NTIPP staff indicates that this problem alone occupies a significant portion of technician task time.*

These faults exhibit a common trait - insufficient priority to the characteristics and needs of the user. Moreover, the complaints cut across the entire technical manual process. For example, compatibility of the manual with the experience/comprehension levels of its users, and with the physical usage environment, are proper subjects of the specifications which govern the procurement of the manual. Effective content, while generally constrained by the specifications, also rests on the preparation/review/approval steps. The publishing and distribution steps loom into view when considering the lack of comprehensive, up-to-date information in the hands of the using technician. Inadequacies as training material become a shared fault of the training and technical manual organizations. From this broad scope, it is clear that prioritizing the needs of the using technician in part of the technical manual process will not solve the overall problem; what is needed is a simultaneous user-oriented approach to each step in the process according to an overall plan. Also, the interactions between the steps in the technical manual process must occur in such a manner as to preserve and enhance the user-oriented features of each.

It is the intent and objective of NTIPP to define and implement such a user-oriented approach to each step in the technical manual process, and to integrate those steps into a cohesive system. Considerable emphasis is necessarily placed upon compatibility between technical manual design and the array of anticipated users and environments. This has been termed the "user-data match," and involves such concerns as reading/comprehension levels, optimized formats and presentation techniques, accommodation of environmental constraints, etc. Results of this user-data match are then to be incorporated into the procurement specifications used by the technical manual acquisition agencies. The improved specifications are to reflect not only the requirements for proper content and user characteristics, but also the guidelines for achieving them in the content generation process and verifying their existence

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*This survey effort will be documented in a separate Hughes report; draft issue to be released on 5 March 1977.

1.2.1 NATURE OF THE TRADITIONAL TECHNICAL MANUAL PROBLEM (Continued)

in the review/approval steps. Publishing and distribution steps are to be refined to safeguard and deliver the improved technical manual product into the hands of the user, and a definitive user feedback channel will provide for more effective handling of complaints and suggestions from the using technician. Timely updates and periodic notifications of total manual configuration (i.e., listing of the basic manual plus all pertinent changes published to date) will achieve recency of the manual and enhance the user's confidence in its completeness.

In this fashion, technician task time can be minimized by eliminating the reducible effort now expended to compensate for shortcomings in the technical manual.

TABLE 1-I. TRADITIONAL TECHNICAL MANUAL PROBLEMS

Areas of Concern	Typical Complaints
Match between manual and user's needs, capabilities, and environment	Manual written for wrong experience and/or comprehension level . . . physical size (especially foldouts) incompatible with work space . . . format not appropriate to equipment . . . media incompatible with environment (e.g., dim lighting, humidity, dirt/grease, etc.)
Adequacy as maintenance/ troubleshooting tool	System-level and interface coverage missing or inadequate . . . insufficient traceability of signal or mechanical flow across schematics, flow diagrams, etc. . . . troubleshooting charts and diagrams not representative of faults actually encountered . . . confusion due to inconsistent nomenclature and abbreviations throughout manual . . . insufficient part number information
Effects of truncated preparation schedules on TM products	Requirements for concurrent delivery of TMs with equipment not compatible with slippages in availability of data base and/or equipment for TM validation . . . TM adequacy and quality suffer

TABLE 1-I. TRADITIONAL TECHNICAL MANUAL PROBLEMS (Continued)

Areas of Concern	Typical Complaints
Missing, obsolete, or incomplete manuals	Manuals (especially system-level) not provided for certain key areas . . . manuals old, using obsolete techniques, but not replaced . . . changes missing or slow in arriving after equipment modifications
Reaction time for reorders and user complaints/ suggestions	Long turnaround times after reordering . . . very long turnaround times for user feedback communications . . .
Impact of technical manual usage on technician task time	Undue time required to find relevant information in manual for troubleshooting . . . incomplete or incorrect instructions cause maintenance delays and errors . . . valuable technician time taken in data-related search efforts (e.g., parts numbers, etc.)
Adequacy of manual as training tool	Designed primarily as maintenance reference document, not classroom instruction aid . . . nonprocedural parts (such as theory of operation) not organized for learning in classroom or on-the-job environment

1.2.2 IMPLICATIONS OF SEPARATE SYSCOM APPROACHES TO NTIPP ISSUES

Variations in SYSCOM approaches tend to impede Navy-wide improvements in technical manual effectiveness and collection of unified cost data. However, since selected variations may be more advantageous than total standardization, both standardizations and variations must be judged against overall cost effectiveness.

Analysis of present and proposed technical manual (TM) operations within the Navy reveals many differences in the handling of TMs by the various SYSCOMs. Although not intended as an exhaustive list in any sense, Table 1-II offers some of the typical areas in which the differences occur.

In a philosophical sense, it could be contended that all differences among SYSCOMs are bad by definition, and that the goal must be total standardization. However, from a more practical viewpoint, two additional observations must be made:

(1) The observed impact of inter-SYSCOM differences varies widely. Some are relatively minor, while others offer major impact on NTIPP research efforts which are expected to result in substantive research efforts which are expected to result in substantive recommendations for improved TMs.

(2) Some differences may result from, and reflect, unique features in TM environments encountered by the various SYSCOMs. In such a case, an inter-SYSCOM difference may even be more cost/effective than the blanket application of standardization. On the other hand, it must be recognized that existing differences have not been based upon having passed any such deliberate test of cost/effectiveness, and hence are of unproven validity at present.

Following this line of thought, it becomes apparent that both the existing differences and the existing commonalities must be judged against the singular basis of cost/effectiveness before either can be firmly accepted or refuted. Simply subjecting the differences to this test will not validate those areas of present commonality. A hybrid solution would likely evolve, consisting of broad applications of standardization tempered by occasional, planned variations in those areas where nonstandardization was deemed to be more cost/effective. Although determining such cost/effectiveness is beyond the scope of Task 1, it is important to recognize that these tradeoffs must yet be made in Tasks 3, 4, and 5 before confidence can be placed in firm recommendations for standardization at specific points in the Navy's technical manual systems.

In the case of some of the minor differences, standardization could presumably be applied without significant detriment. Nomenclature, for example, is not consistent; variations exist among the SYSCOMs in acronyms, abbreviations, and basic terms. Also, issue of TM numbers does not have the same meaning, although the formats of the numbers themselves are in the process of being standardized; in NAVELEX, issue of a TM number indicates that the TM has undergone and completed review and approval, while similar number issue in the other SYSCOMs indicates that the TM is authorized to be written, or that the review/approval process has begun.

Some of the differences in TM specifications readily reflect SYSCOM format preferences, e.g., Work Package approach for NAVAIR, and FOMM for NAVSEA. Similar distinctions exist in microform utilization. These must be evaluated before attempting standardization.

Other differences are more serious because they tend to impede attempts to upgrade the technical manual operations. For example, the manners in which the SYSCOMs collect and document TM costs renders quite difficult any attempt to compare such costs for future reference. Also, differences in handling of TM changes and feedback items presumably make it more difficult for Navy personnel familiar with operations in one SYSCOM to readily operate in another.

Two possible reasons exist for the differences now found among the SYSCOMs. One of these is inadvertent divergence - the accidental taking of separate paths where no higher-level doctrine or policy exists. The other is "tailored interpretation" of policies and doctrines where they do exist. At each level, the flowdown of higher-level directives appears to be interpreted and tailored to fit the unique characteristics of that level. While such tailoring may largely be unavoidable, it can at least be minimized through cooperative planning of variations and standardizations by the SYSCOMs, or even (as suggested by some) through centralization of technical manual operations above the SYSCOM level.[1]

TABLE 1-II. TYPICAL INTER-SYSCOM DIFFERENCES IN TECHNICAL MANUALS

Item	Detail or Impact
Techniques for Cost Collection	Technical manual cost data from the respective SYSCOMs not readily comparable without extensive transformation or interpretation
Terminology	Differences in acronyms, abbreviations, and basic terms may tend to confuse readers of TMs from more than one SYSCOM
Microform Approach	SYSCOMs are becoming committed to capital outlays for different types of microform reader/printer hardware
Format Specifications	Contractors doing business with more than one SYSCOM must become familiar with format details of each, using separate governing documents
Review and Approval of TMs	Validation/verification practices not standard; TM number issue has different meanings
Handling of Changes and Feedback Items	Hardware-related changes characterized differently; NAVAIR beginning to separately identify TM deficiencies from hardware deficiencies in feedback reports

[1] Central Management of Technical Manuals for the Fleet, Report of NAVMAT Ad-Hoc Committee in Response to CNM Action Sheet 61-73, 19 April 1974.

1.2.3 EVALUATING THE RELEVANT TECHNOLOGIES

The primary technology impacts are closely related to the media alternatives probable in the 1980 timeframe. Additional technology considerations center on the type of weapons system requiring technical data support in the 1980-1990 period.

Any discussion of technology on NTIPP as a program must be carefully focused. A number of technologies are likely to impact the projected output products of concern to NTIPP in the 1980 timeframe as well as the processes used to create those products. All technology impacts ultimately come to rest with the user environment. With that in mind, the primary focus could be traced from a specific medium whose existence is probable in the 1980 timeframe, and then the impact of that medium on the processes necessary to bring it into being as a practical tool for the user in training, operation, and maintenance. It is recognized that discussions of "media" tend to bring a number of preconceived notions to the mind of the reader; however the search for an alternative word has been disappointing.

Media can be grouped into two main categories for analytic purposes: (1) those exhibiting reasonably "passive" characteristics to the users and (2) those media which users view as "active." The definitive need for a Media Evaluation Laboratory was discussed in the First SFTOA Quarterly Report of 24 September 1976. Considerable danger is contained in attempts to "swap data bases" from one medium to another without serious consideration of the very real differences in capabilities and limitations of the media. For example, the application of the "data base" used in printed page technology to roll microfilm ran squarely into media problems which could have been determined to exist in a laboratory environment. As it turned out, the fleet became the laboratory and the user reactions (as well as costs) are still rolling in. This impact is discussed at length in Topic 3.1.1.5.

Table 1-III lists various media in two columns, Passive and Active. The categories are somewhat arbitrary in that roll microfilm is more "active" (spinning in a cartridge) than is a printed page (manually flipped by hand); yet from a user eyescan point of view, both are passive. In the "Active Media" column, a distinction is made between "Lockstep" and "Interactive." "Lockstep" means that the data is related to the user at a rate prescribed by the machinery displaying the image (and sound in an audio-visual medium), whereas Interactive indicates that the user (not the machinery) has far greater control.

Also, the video disc is located in both the Passive and Active columns (and mentioned twice in the active column). This was done intentionally, to point out the extreme versatility of this single medium. Video disc could be used as a substitute for roll microfilm as well as video tape. Further, video disc can be substituted for magnetic memory when considered as an "optic memory." In each instance the "data base" would have to change drastically to be meaningful to the user. The impact on NTIPP from a product and process viewpoint differs dramatically in each application of video disc. As a microfilm substitute, some sort of player is needed for the user to scan the images recorded optoelectronically on the disc. However, in use, the technician would be hard-pressed to tell the difference between roll microfilm and video disc

("rewind" would take less time). The "data base" content of the disc would "look" like microfilm and "act" like microfilm.

When considered as a video tape substitute for use in refresher training, the user would "play" the disc in a fashion similar to "playing" a video tape. Obviously, the content generator must now create the needed "data base" and this "data base" is quite different from that created for use as a microform substitute.

Finally, the whole "data base" structure (and thus the content generator output) changes remarkably when considering video disc as an interactive medium. The "player" must have the capability to react to user control, and the data base would be in digital form (text display) as well as analog (audio-visual a la video tape and illustrations). The point is that the single medium of video disc raises many facets to consider, and impacts NTIPP in a number of ways, all of which must be carefully considered.

In addition to the impacts of the differing applications of video disc on the content generator, the replication machinery changes drastically from that required for the print-image media in use today. In fact, the video disc could find use in the content capture and replication functions as an intermediate medium from which printed data is directed. All in all, it is felt that the process and product aspects of technology are best considered by utilizing the media viewpoint.

The serious question of the kinds of weapons system technology that will require technical data support in the fleet environment in the 1980s is still being addressed. It appears logical to conclude that "more electronics" is the rule; however, built-in test equipment, monitoring, and self-diagnostic trends are extremely difficult to discern. Preliminary data from the fleet survey* indicates a certain amount of user dissatisfaction due to increased complexity in the systems caused by the addition of built-in diagnostics, monitoring, and diagnostics. The trend toward increased sophistication in the engineering spaces and the application of gas turbines is quite distinguishable at this time. Therefore, the User-Data Match research is carefully considering the impacts indicated by this trend.

TABLE 1-III. EXAMPLES OF PASSIVE AND ACTIVE MEDIA

Passive Media	Active Media
• Printed Page • Microfilm • Optical Holograms • Video Disc	<u>Lockstep</u> • Movie Film • Film Slides with Audio • Video Tape • Video Disc <u>Interactive</u> • Magnetic Disc • Video Disc

*Survey of Fleet Technical Manual Users by the NTIPP staff, to be documented in a separate Hughes report; draft issue to be released on 5 March 1977.

1.3 SCOPE AND APPROACH

The scope of Task 1, Analysis of Current and Proposed Technical Manuals, was bounded by the expenditure of about 55 man-months of effort over a seven-month period. The overall approach was based upon the application of systems engineering principles to the research efforts; this established the output requirements for Task 1, and gave rise to the Research Issues which served as engineering transforms around which to focus the research.

Schedule and Resources Allocation - The timeframe for the conduct of Task 1 is defined as beginning with the inception of contractual coverage on 24 June 1976, and culminating with the delivery of the draft Task 1 report on 24 January 1977.

Across this timeframe, an incremental staffing plan provided for a research force ranging from 6 to 18 individuals who concurrently performed Tasks 1 and 2. This resulted in the expenditure of approximately 75 man-months of NTIPP effort, of which about 55 man-months are attributable to Task 1. (Not included in these figues is the resource allocation to the NTIPP Fleet Survey of TM Users, which is described in a separate report to be delivered on 5 March 1977.)

Overall Approach to Conduct of the Research - As described in the Hughes NTMS Proposal of 29 October 1975, the key to the Phase I effort (including Task 1) was to apply the principles of systems engineering to the research activities. This had two major impacts on Task 1:

(a) The overall task structure within Phase I was established to promote and exploit the iterative baseline methodology of the systems engineering discipline. As a result, the output of Task 1 is constrained by the obligation to satisfy the input needs of Task 2 (establishment of preliminary NTIPP requirements) and Task 3 (synthesis and tentative selection of alternatives to form a preliminary baseline). This means that the information gathered and processed in Task 1 must serve the dual role of a data base suitable for separately formulating requirements and alternatives. Section 2.1 describes the relationship of Task 1 to the total NTIPP effort in greater detail.

(b) Within Task 1 itself, it was found useful to employ the systems engineering technique of a methodology transform; to properly link the proposed task structure (from the Hughes NTMS Proposal) with the contractual Statement of Work, nine Research Issues were formulated for use as focal points around which the research in each Task was to be conducted. The rationale for the formulation of these Research Issues, and the role of each, are described in greater detail in Section 2, Methodology.

Approach to Recommendations - In response to the provisions of Data Item Description UDI-S-7060, Section 6 of this report is dedicated to the subject of Recommendations. In addition, lower-level recommendations are explicitly disclosed where appropriate within the analyses of current and proposed technical manual systems in Section 3. However, in this connection, it should be recognized that merely reporting the existence of an item and analyzing its

relevance to NTIPP does not constitute a recommendation for or against the consideration of that item in future tasks and/or phases of the NTIPP effort. Where recommendations are intended, they are clearly identified as such in explicit language.

Consideration of Non-Navy Technical Manual Operations - To maximize the scope of comparisons within the analyses of Task 1, investigations were extended beyond U.S. Navy operations to those of the Army and Air Force, and of other Governmental agencies and civilian firms whose operations are similar (in part or in whole) to those of current Navy technical manual organizations. Examination of non-Navy organizations was not intended to be performed to the same depth as was that of the Navy, since the former category of information serves only for purposes of broad comparison with Navy technical manual organizations.

Definition of "Current" and "Proposed" Technical Manual Systems - Because no clear-cut line of demarcation exists between the categories of "current" and "proposed" technical manual systems and techniques, the analyses of which are the subject of Task 1, it was necessary to establish definitions of convenience for these categories.

In this regard, current technical manual systems and techniques are defined as those which are now in widespread use, or at least have significantly impacted Fleet operations, within the judgment of NTIPP researchers. Proposed technical manual systems and techniques are then defined, necessarily, as those which have not yet attained the status of widespread fleet impact.

It is recognized that these definitions affect several techniques and approaches which are intended to improve technical manual operations, and which have been approved for implementation by the SYSCOMs or other appropriate service or organization. To the extent that these items have not yet achieved widespread impact on the fleet, they are treated herein as proposed items rather than current. Credit for such improvements is therefore given to the appropriate command under the discussions of proposed systems. In such cases, the need for improvement is noted in the analyses of current systems, so as to establish the basis for analyzing the usefulness of the improvement in its subsequent coverage under proposed systems.

1.4 LIMITATIONS

Four types of limitations constrained the Task 1 effort and this report. These involved schedule/cost factors, delay in the human factors effort, differences in scope of the analysis of U.S. Navy technical manual operations and those of other services and organizations, and delay/unavailability factors encountered in obtaining reference documents.

Limitations Involving Schedule/Cost - Inherent limitations in the scope of Task 1 are offered by the preplanned expenditure of some 55 man-months of effort and appropriate funding across the Task 1 reporting period of seven months. (The reporting period is defined as commencing with contract award on 24 June 1976 and continuing through 24 January 1977.)

Human Factors Delay - During the conduct of Task 1 it became necessary, in the interests of the Navy, to replace the previously selected human factors subcontractor with Anacapa Sciences, Inc., of Santa Barbara, California. Since Anacapa's effort will not be completed until March 1977, human factors analysis information available to the Task 1 report was limited to that contained in preliminary progress reports from Anacapa. As a result, present findings in Research Issue 1, User-Data Match (of which the human factors analysis is a significant and integral component) are potentially influenceable by further results as reflected in Anacapa's March 1977 report.

Differences in Scope - The analysis of current and proposed technical manual systems was not restricted to the U.S. Navy; pertinent operations of the U.S. Army and Air Force, of various nonmilitary Governmental agencies, and commercial firms were examined as well. However, the analysis of these other services and organizations was not performed to the same depth as that for the Navy operations, since the non-Navy areas were evaluated only for purposes of broad comparison.

Acquisition of Reference Documents - The research of Task 1 required access to a wide variety of reference documents, ranging from specifications and instructions to reports by military agencies and private contractors. This type of information is typically available through requests to the Defense Documentation Center, the Defense Logistic Studies Information Exchange, the cognizant military agencies, etc. Of approximately 700 documents ordered prior to October 1976, about 50 have yet to be received. For the others, turnaround periods of two to four months have been typical. These extensive delays have served to truncate the time available for analysis of such documents for impact on Task 1 results.

1.5 PLAN OF REPORT

This Task 1 Report, CDRL A001, conforms to the requirements of Data Item Description UDI-S-7060. For convenience, the body of the report is divided into separately accessible discussions of current and proposed technical manual systems from the viewpoint of each Research Issue in turn. Glossary and Bibliography information is provided in the appendices.

This document is the first of five end-of-task reports which are governed by the provisions of Data Item Description (DID) UDI-S-7060, dated 1 July 1975, from the David W. Taylor Naval Research and Development Center, Code 186A, Bethesda, Maryland. The above DID specifies the utilization of Sections 1 and 2 as Introduction and Methodology, respectively, and the last two sections (herein 5 and 6) as Conclusions and Recommendations, respectively. Intervening sections (herein 3 and 4) are to be utilized for the body of the report. Appendices as needed are permitted by the DID.

Section 2, Methodology, is divided into three discussions - the relationship of Task 1 to the overall NTIPP effort, the need for the Research Issues as devices for transforming the scope of work, and the utilization of those Research Issues during the Task 1 effort.

Having so established the Research Issues as the focal points around which the research was conducted, Section 3 presents the research findings and analyses on a per-Research Issue basis. Research Issue discussions are treated in successive modular sections (3.1 through 3.9), each with its own divider and local table of contents for convenience of access. In each of the Research Issue discussions, clear delineation is made between the definition and objective of the Issue, the analysis of current technical manual systems, and the analysis of proposed technical manual systems, with respect to that Issue.

Section 4, Feature Analysis, is a preliminary disclosure of the quantitative and qualitative attributes which will be employed in subsequent tasks of NTIPP Phase I - Systems and Feasibility Tradeoff Analyses. The principal use of these attributes (termed Features and Measures of Effectiveness) will be to distinguish preferred choices from the viable alternatives in preliminary baselining during Task 3, and in the performance/cost tradeoffs of Tasks 4 and 5.

The report contains two appendices. One is a Glossary of abbreviations and acronyms used in the report, and the other a Bibliography of documents consulted during the Task 1 effort.

SECTION 2
METHODOLOGY

2.1 RELATIONSHIP OF TASK 1 TO THE OVERALL NTIPP EFFORT

Task 1, Analysis of Current and Proposed Technical Manual Systems establishes the information base necessary for establishing the NTIPP Requirements of Task 2, and for synthesizing the alternatives in Task 3.

The conduct of Task 1 is the starting point for NTIPP Phase I - Systems and Feasibility Tradeoff Analyses (SFTOA). Included in the scope of Task 1 is the development of information describing the operation of technical manuals systems presently in use, and those now proposed. This analysis covers the U.S. Navy Systems Commands (SYSCOMs) in depth and, to a lesser degree of detail, the operation of similar systems in the U.S. Army and Air Force as well as other selected organizations, for additional reference. Information thus derived was then evaluated and analyzed through comparison between the real-world systems now in force, between current and upcoming systems, and between current systems and the idealized conduct of technical manual functions as defined by NTIPP.

The relationship of Task 1 to the other SFTOA Tasks is shown in simplified form in Figure 2-1. The results of Task 1 form the basis for Task 2, Establishment of NTIPP Requirements, and Task 3, Development of the Preliminary NTIPP System Definition and Alternative Configurations (Baseline). The nature of these inputs to Tasks 2 and 3 is as follows.

The information base developed in Task 1 represents the basis for synthesizing the initial set of overall NTIPP requirements in Task 2. This is enabled through the rigorous examination of present and proposed technical manual systems of the U.S. Navy and other services and organizations, and through the application of engineering judgments insofar as the effectiveness of these systems is concerned. Also incorporated in the requirements synthesis process is the idealized conduct of the necessary functions of any technical manual system. This idealized conduct is also an output of Task 1, and is reflected in the Research Issues of the NTIPP methodology; it is derived both from the Hughes NTMS Proposal and from system-oriented observations of real-world technical manual operations.

The output requirements of Task 2, in turn, not only reflect the Task 1 information but also serve to constrain the synthesis of preliminary alternatives in Task 3, in that any valid alternative established for consideration in Task 3 must first satisfy the Task 2 requirements.

As seen in the figure, the results of Task 1 also have a direct influence on Task 3, since the Task 1 output is the principal source of information from which to synthesize the alternative configurations of NTIPP, in whole and in part. Hence, the Task 1 results serve a dual role - as an engineering data base for synthesis of alternatives, and as the basis for requirements which, in turn, constrain the consideration of such alternatives. However, Task 1 results do not retain this principal role subsequently; further SFTOA tasks utilize the results of Task 3 as the principal base, since those results represent the first depiction of the evolving baseline for NTIPP.

Because of the strong impact of Task 1 results (and, for that matter, those of Task 2 as well) Navy approval of these results is incorporated through the mechanism of draft end-of-task reports for Tasks 1 and 2; these

drafts have been offered for review and approval, with changes as required, prior to commencing Task 3. This assures Navy concurrence with the status and completeness of the data base which plays a key role in further SFTOA tasks within Phase I.

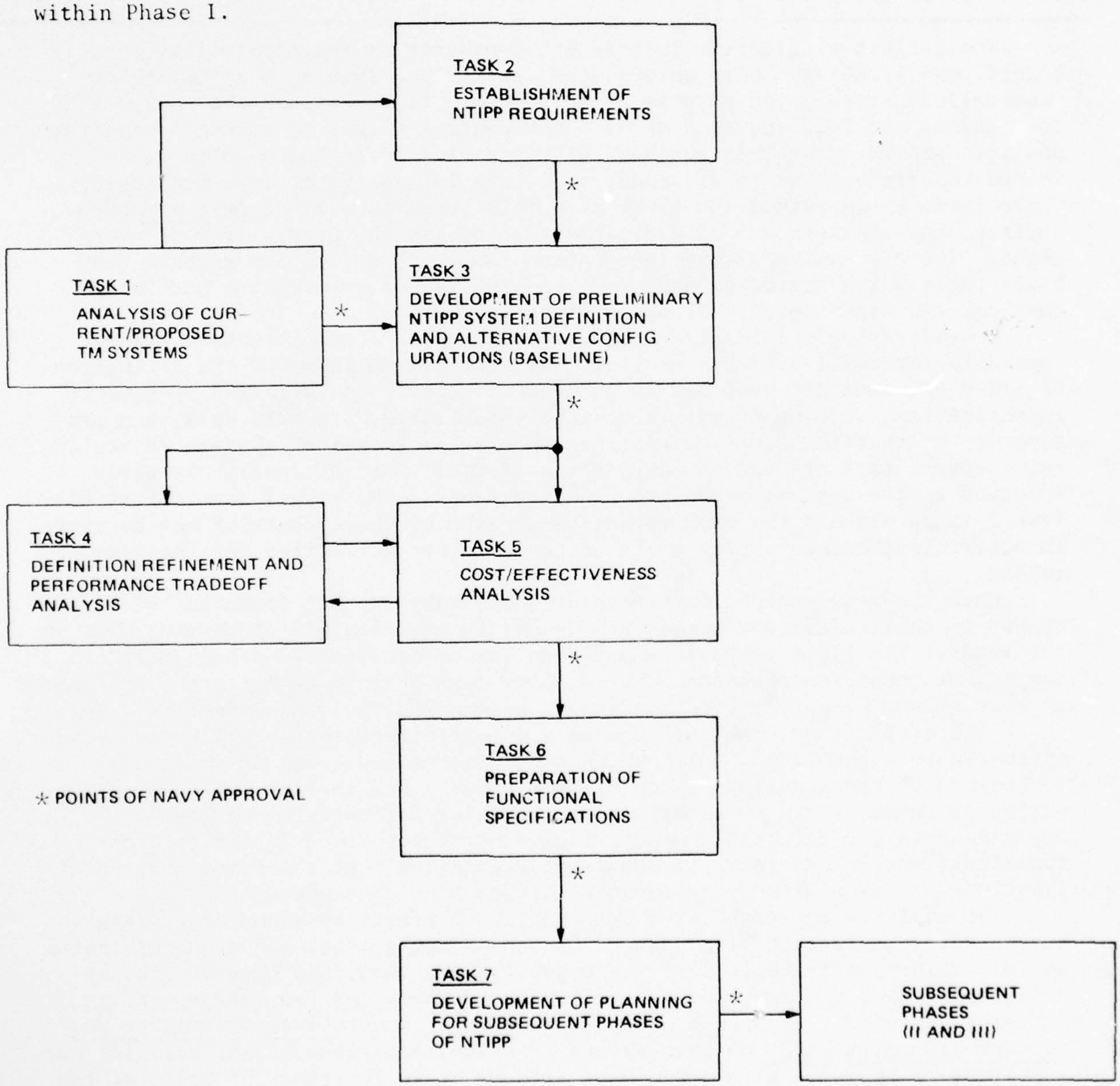

Figure 2-1. Relationship of Task 1 to Overall NTIPP Effort. Results of Task 1 constitute the principal information for conduct of Tasks 2 and 3, with Task 2 results serving as a control mechanism to screen potential alternatives.

2.2 USE OF SYSTEMS ENGINEERING TECHNIQUES

A comparative structured systems analysis is the basic tool employed in the conduct of Task 1. These results are not to be construed as critical, but merely as points of interactive discussion with SYSCOM practitioners for the purpose of ensuring complete design at the close of Phase I.

The largest single risk in this R & D program is the possibility that a significant issue may "slip through the cracks" and remain in an "open" or "unresolved" state. The purpose of this report is to discuss the analysis of the Current and Proposed TM Systems. The central thrust to accomplishing this analysis and bringing this phase of NTIPP to closure (as opposed to open-looped research) is the strict adherence to a logically complete methodology. There is no known method to ensure that this research will cover every eventuality; however methods are available to diminish the probability of oversight. The discussion of the Integration issue in Section 3.9 relates the basic tools which are being employed, and the reader is urged to carefully consider the NTIPP Research Issue of Integration.

Consideration should also be given to the NTIPP task structure illustrated in Topic 2.1. Task 1 provides the basic foundation for the definition of NTIPP requirements provided in the Task 2 report. As with any systematic investigation, a point of origin must be established. In this case, the presumption is that the steps being taken to provide technical manuals relate to requirements that are known today, either formally or informally, by those involved in the current technical manual process. The significant effort of Task 1 is to discuss the requirements indicated by the conduct of the current TM activities, and to evaluate the proposed future activities for the same reason.

Once the requirements have been defined, they are set forth in the Task 2 report as constraints on further approaches to creating and processing MOTD in the 1980s. The logic is basic - any baseline or alternative design must at least meet these requirements. The work of Task 3 is to conceive the systematic approaches and competing alternatives to accomplish those requirements. Once these are established, the performance and cost/effectiveness evaluation processes can be accomplished on the competing alternatives, all of which are responsive to the requirement constraints established in Task 2. Completion of the performance and cost/evaluation processes defines the successful approach with the detailed characteristics being described in the form of functional specifications. It should be recognized that the functional specifications are also NTIPP requirements, although at a detached level.

The analytic approach taken for the Task 1 effort is known as a "structured system analysis." The process is one of comparison, and requires that a set of evaluation criteria first be established. Then, the current and proposed approaches are compared against these criteria and the matches and differences noted. It is not intended that this comparative analysis be any part of a "report card" on the various TM processes, products, or policies currently being employed within the Navy SYSCOMs or in the other branches of the military. The entire purpose of Task 1 is to ensure that the "whole" TM problem has been bounded, not to "point fingers." The intent is rather to raise

critical points, interact with the SYSCOM practitioners, view competing ideas, and fully define the many facets of MOTD for the sole purpose of designing a comprehensive baseline. In point of fact, this effort is SYSCOM research for *the sole intent* of defining approaches that are viable and cost/effective in future SYSCOM activity. Hughes Aircraft Company intends to leave the criticism to the critics, and diligently pursue the design aspects of this problem.

2.3 NEED FOR TRANSFORMATION OF THE ORIGINAL WORK STRUCTURE

The work structure and approach described in the Hughes proposal for NTMS was utilized as an initial point of departure in Task 1. It was found that a transform was needed for effective correlation of the proposed studies with the Systems and Feasibility Tradeoff Analyses (SFTOA) tasks.

The work structure contained in the Hughes proposal consisted of the SFTOA Tasks defined in Paragraph 6.1 of the Request for Proposal, as illustrated opposite, 16 Feasibility Studies and System Tradeoffs, and 10 Tradeoff Studies. The intent of SFTOA was to evaluate the alternative concepts for each of the 16 separate points, and then to select (or confirm) the best approach for each point. It was recognized that no time existed for basic research, and that a disciplined application of Systems Engineering principles was to be applied by confirming the best of the competing (or alternate) concepts and freezing these into an evolving baseline design structure. The same approach was intended to apply to the proposed Tradeoff Studies.

The attempt was then made to match the proposed studies against the task structure. Two functional planning networks were created and reviewed informally. At this juncture, this approach appeared to be reasonable and work was initiated on Task 1, Analysis of Current and Proposed TM Systems. The weakness became apparent. The application of the 26 Studies and Tradeoffs to the first six SFTOA Tasks resulted in mismatch, as no apparent way existed to relate these studies to the required Tasks in a functionally coherent and cohesive manner.

An intensive analysis was conducted and the causes of the problem were determined. Basically, each of the 26 studies proposed was sound in its own right, as were each of the required SFTOA Tasks. The problem was characterized both by "independence" - the studies were far too independent of the task structure - and by "multiple dependence" involving previously undetected mutual influences between the arrays of tasks and studies. An example of the latter was the Proposed Study for Head/Book Tradeoff, which was found not to be simply a Tradeoff Study, but a process that was vital to consider in the first five SFTOA tasks, although the considerations of Head/Book Tradeoff would vary quite widely from task to task.

Several attempts were made at structuring a new set of studies more closely related to the tasks of SFTOA. This attempt was short-lived in that it simply reconfirmed that there was nothing wrong with the proposed studies per se, as well as being essential to the accomplishment of SFTOA. Recognition of the basic value of the Proposed Studies and the strength of the Task Structure led to the conclusion that a transform function was needed to relate the studies functionally to the SFTOA Tasks. The utilization of "System Research Issues" as the needed transform was postulated and tested, and resulted in a unified approach which linked the Studies to the Tasks in a highly successful manner. A description of these research issues and their role is given in the succeeding topic.

TABLE 2-I. NTIPP TASKS IN SFTOA

Task No.	Title
1	Analysis of Current/Proposed Technical Manual Systems
2	Establishment of NTIPP Requirements
3	Development of Preliminary NTIPP System Definition and Alternative Configurations (Baseline)
4	Definition Refinement and Performance Tradeoff Analysis
5	Cost-Effectiveness Analysis
6	Preparation of Functional Specifications
7	Development of Planning for Subsequent Phases of NTIPP

TABLE 2-II. STUDIES TO SUPPORT BASELINE DEFINITION

TRADEOFF STUDIES

- Specification Systems
- MOTD Maintenance Worth Determination
- Maintenance Manpower Reduction
- Training Time Reduction
- Graphics Entry Methods
- Text Entry Methods
- Printing Automation
- Automated Production (COM vs Photocomposition)
- Automated Distribution
- Quick-Reaction Production

FEASIBILITY STUDIES

- MOTD Creation Techniques
- TM Presentation Techniques
- Readability Improvement
- TM Review Team Definition
- TM Presentation Handbook
- Readability Test Method
- Automated Graphic Processing
- Voice Recognition for Data Entry
- ADP Applications to Archive

SYSTEM TRADEOFFS

- NTMS Cost Monitoring
- TM Life Cycle Cost Methods
- Configuration Management
- Systems Management Automation
- Head/Book Tradeoff Criteria
- Media Selection
- Validation and Verification

2.4 RESTRUCTURE THROUGH THE RESEARCH ISSUE TRANSFORM

The concept of functional research issues was developed and applied as a useful transform between the task structure and the proposed study. This provides functional continuity of the research work being undertaken, and serves as a cohesive force to focus relevance on each of the proposed studies.

The transform function needed to relate the Proposed Studies to the Task Structure took the form of Research Issues. The resulting planning structure is shown on the facing page. Nine Research Issues were postulated and tested for effectiveness in "bridging the gap," and an issue manager (or principal investigator) assigned to each. It should be noted that the research issues will carry through each of the SFTOA Tasks; even though the emphases will change, the issues will remain as defined.

The issue manager will track those facets of the studies pertinent to the SFTOA Task being executed. By way of explanation, consider the Head/Book Tradeoff, used as an example of the previous topic. Head/Book Tradeoff is an important study to three research issues: (1) Matching the User and the Data, (2) Acquiring the Matched Data, and (3) Generating the Content.

The beginning point for Head/Book Tradeoff is in Research Issue 1, Matching the User and the Data. A considerable amount of ground is covered by the expression "Matching the User and the Data." The "user" in this case involves three major elements: (1) the system or equipment being supported, (2) the environment in which that system or equipment is operated and/or maintained, and (3) the human factors of the technician responsible for operation and/or maintenance. The technician's role cannot be removed from the system, the equipment or the environment for purposes of NTIPP evaluation. To do so would markedly reduce the value of the analyses and subsequent design synthesis efforts, and severely limit the value of NTIPP as a whole.

The pertinent facets of this study are concerned with the determination of what should go in the head via training or technical data, and the format and media of data to be located in the technical manual such that it translates most effectively to the head. Points of consideration with respect to the data are the frequency of use, the complexity, and the criticality. The results will be applied to Research Issues 2 and 3. Head/Book items of concern to the Acquire the Matched Data issue are as follows: (1) Determination of how to conduct the Head/Book Tradeoff with the training and maintenance people within the Navy, (2) Specifying the book structure based upon Head/Book criteria to the content generator (contractor), and (3) Testing to ensure that the Head/Book decisions have been included in the TM product produced by the content generator. Insofar as the Generating the Content issue is concerned, the Head/Book Tradeoff is of interest because the content that is generated must reflect the principles defined in Issues 1 and 2. Additionally, a substantial degree of freedom must be allowed to avoid placing the Navy in the position of overly dictating to industry. The Hughes position is that the content generation issue results must allow the Navy to achieve the desired match between the user, the equipment or system, the environment, and the data, without unduly constraining the industry. Historically, the

industry has fought constraints by increasing cost. The challenge is to provide the appropriate constraints without unduly alarming the contractor, and demonstrating that the results are in their best interest as well as that of the Navy.

In summary, the role of the issue manager is to determine those facets of the proposed studies relative to each task of SFTOA on the assigned issue, and to ensure that the appropriate work is accomplished within that functional context and in a timely manner.

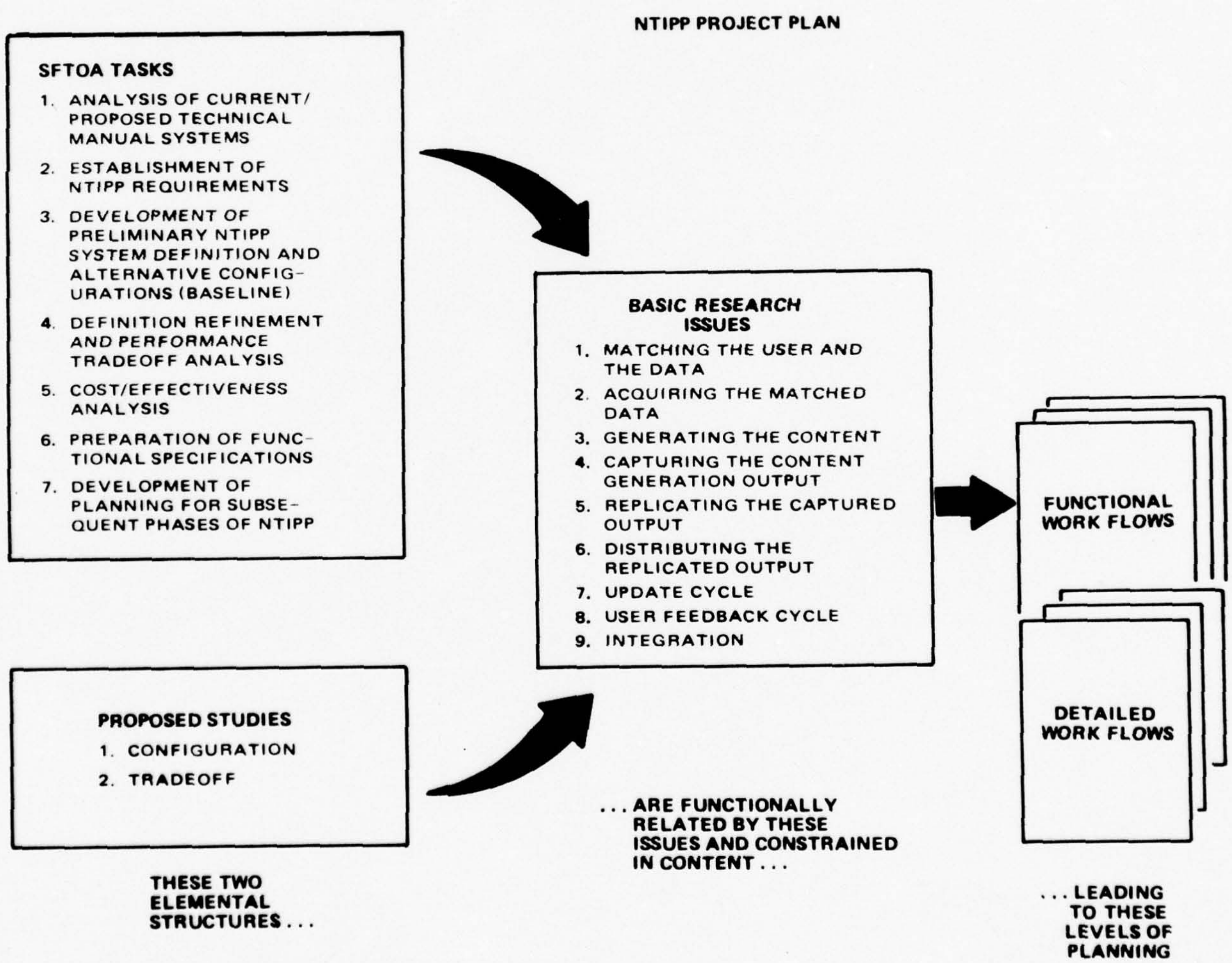

Figure 2-2. Concept of Relationship Drawn Between Tasks and Studies by Means of Research Issues. The nine Research Issues will be applied to each of the seven SFTOA Tasks.

SECTION 3
DATA COLLECTION AND ANALYSIS

NOTE

Section 3 is divided into nine modular subsections, each of which contains an analysis of current and proposed technical manual systems appropriate to one of the Research Issues. Each subsection is provided with its own divider/contents page (on gray stock) for ready reference and information retrieval.

SUBSECTION 3.1

RESEARCH ISSUE 1: USER-DATA MATCH

Section 3 - Data Collection and Analysis
3.1 - Research Issue 1: User-Data Match
3.1.1 - User-Data Match Research Philosophy

3.1.1.1 DEFINITION AND OBJECTIVES OF USER-DATA MATCH RESEARCH ISSUE

The User-Data Match research issue constitutes a comprehensive analysis of established and state-of-the-art human engineering principles and their application to the design and development of MOTD.

The end result of this analysis will be a methodology for the development of MOTD in its most useful form based on an effective balance among the various combinations of user personnel characteristics; job tasks as dictated by the equipment/systems worked on; environmental conditions; training considerations; maintenance philosophy; and appropriate formats and media techniques for the presentation of technical data.

As part of the User-Data Match research issue, an investigation was conducted of current and proposed MOTD systems with respect to the human engineering considerations inherent in each system. Research showed that most attempts to date at solving the TM problems have been of a singular or piecemeal nature, attacking one symptom at a time. Current and proposed developments also largely appear to address one or two major problem areas while playing down the importance of others. It is believed that an effective total solution cannot be achieved without undertaking a comprehensive, uniform approach which addresses all of the variables and problem areas equally and simultaneously. Experience has shown that often the cure for one symptom alone usually leads to additional problems elsewhere.

NTIPP research, as well as the research of others, and preliminary data from the HAC NTIPP Fleet Survey[1] indicate that most technicians find conventional TMs to have serious deficiencies and are, at best, difficult to use. Many of the deficiencies cited are due to one or more of the following: poor quality of presentation modes; writing levels not matched to user's reading abilities; an inadequate balance among "what to do," "how to do," and "why"; formats are not standardized; TM is too difficult to use due to environmental factors; etc.

Results of the User-Data Match research are intended to assure that technical documentation meets all the user's data needs and requirements. By meeting these needs and requirements, major MOTD defects will be eliminated and thus MOTD usability and credibility will be greatly improved. It is expected that improved MOTD usability and credibility will increase fleet operational readiness which is often impaired due to unsatisfactory operation/maintenance performance caused by the tendency of technicians to limit or reject the use of TMs because they do not meet their needs. At this time, it is impossible to quantify exact cost savings or precisely measure the amount of increased fleet operational readiness, because data in these areas either does not exist or is not readily accessible. Therefore only qualifiable assumptions based on the evidence at hand can be made.

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[1] This survey effort will be documented in a separate Hughes report; draft issue to be released on 5 March 1977.

Research indicated that in today's world, conventional MOTD is not keeping pace with ever-increasing support requirements.[1,2] Complex equipment design and the use of computer technology has caused tremendous changes in repair techniques and maintenance concepts, such as the use of built-in test equipment. As a result, technicians have been forced into almost total dependency on the technical manual and other forms of MOTD to properly operate/maintain their equipment. Whereas in the past the technician was often able to "ad lib" the repair of a piece of equipment because most equipment/systems were relatively simple in nature, this is no longer possible. If the necessary technical information in a suitable form is not contained in the MOTD, the technician virtually cannot perform his job duties satisfactorily.

Evidence, as well as intuition, indicates that the trend toward increasingly more complex equipment/systems will continue to gain momentum through the 1980s time period.[1,2] Thus, it is imperative that the MOTD needed to support the fleet be as perfectly matched as possible to the user, taking into consideration all the components of the User-Data Match. These components are outlined in Figure 3-1 and discussed in detail below.

Personnel Characteristics - To achieve an effective User-Data Match, certain user personnel characteristics must be taken into account - Basic Test Battery scores which indicate arithmetic reasoning, mechanical comprehension, and basic intellectual ability; Navy rate and/or rating; reading ability; years of related on-the-job experience; formal education, Navy schooling; etc. Recent research studies have shown that various personnel characteristics either directly or indirectly have a predictable bearing on a technician's ability to comprehend printed materials, and therefore represent important factors to be considered in attempting to match the user with appropriate formats and media for presenting the MOTD he needs.[3,4]

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[1] Keneman, Harry L., "Specifications and Guides, or the Technical Writer's Dilemma," Naval Air Systems Command, May 1975.

[2] HAC NTIPP Fleet Survey. This survey effort will be documented in a separate Hughes report to be issued on 5 February 1977.

[3] Powers, Thomas, "Navy Enlisted Personnel Characteristics - Preliminary Analysis," Man Tech Corporation, June 1976.

[4] Githens, William H., "Personnel Characteristics Relevant to Navy Technical Manual Preparation," Naval Personnel Research and Development Center, San Diego, December 1975.

3.1.1.1 DEFINITION AND OBJECTIVES OF USER-DATA MATCH RESEARCH ISSUE (Continued)

Equipment/Systems and Task Analysis - Another element of the User-Data Match which must be addressed in achieving effective MOTD is a detailed analysis of the equipment/systems the technician works on. This analysis should include a comprehensive description of the equipment/system; a definition of the maintenance philosophy imposed on that equipment/system; and a complete functional job task analysis of the duties the technician must perform with respect to the equipment/system such as maintenance tasks, troubleshooting, repair tasks, etc.

Maintenance Philosophy - As part of the analysis described above, definition of the maintenance philosophy imposed on the equipment/system must be specified. This definition should encompass such things as: the level of fault isolation; mean time to repair the equipment/system failure; existence of Built-In Test Equipment/Automated Test Equipment/computer diagnostics; need for manual troubleshooting; etc.

Environmental Constraints - Environmental variables which may impact the technician's ability to use and comprehend the MOTD must be designated. These variables include such things as: illumination; wind; noise; dust; dampness; work space constraints; etc.

Training Considerations - Various considerations with regard to training must be made if the MOTD is to effectively match the user's needs and requirements. Among these are: the technician's present knowledge and capabilities; additional knowledge and skills he will need; the best manner for acquiring these skills and knowledge - by use of MOTD on the job, through on-the-job training, and/or through Navy schooling and training; extent to which he can use specific MOTD in training; etc. These considerations are discussed in detail in Topic 3.1.1.3, Head/Data Training Trade-Off.

Presentation Techniques - Of major importance in achieving an effective User-Data Match are the technical information presentation techniques employed to present the required MOTD to the user. These techniques fall into two categories unique from each other but directly related: formats and components of formats (eg, JPA, FOMM, "hybrid") and media (paper, microform, video disc, etc.). These techniques must be chosen from the point of view of their appropriateness to the user's specific data requirements as already defined according to the other elements of the User-Data Match, and the effectiveness of communication with which the chosen techniques convey the required information.

In the NTIPP analysis of current and proposed MOTD systems to determine how each addresses the elements inherent in the User-Data Match, traditional, widely used, and unique systems were analyzed. A discussion of each is contained in Sections 3.1.2 and 3.1.3.

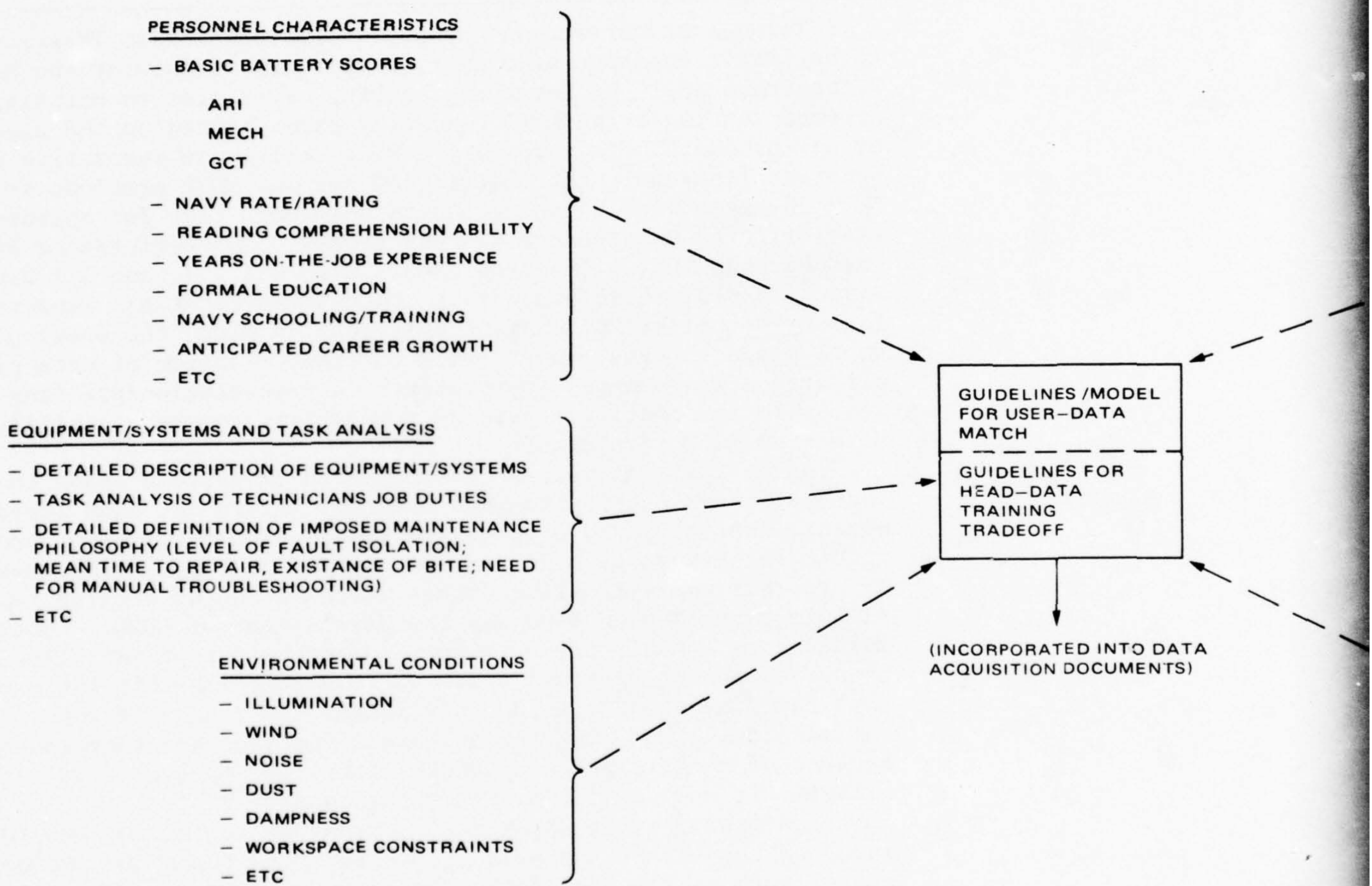

Figure 3-1
Match rese
developing

GUIDELINES/MODEL FOR USER–DATA MATCH

GUIDELINES FOR HEAD–DATA TRAINING TRADEOFF

INCORPORATED INTO DATA ACQUISITION DOCUMENTS)

PRESENTATION TECHNIQUES

MEDIA:
- PAPER
- MICROFORM
- AUDIO
- AUDIO VISUAL
- VIDEO DISC
- ETC

FORMATS AND COMPONENTS OF FORMATS:
- JPA
- FOMM
- ITDT
- IPB/DAPIL
- ETC
- COMPONENT PARTS OF ABOVE FORMATS

TRAINING CONSIDERATIONS
- TASK ANALYSIS INFORMATION ON TECH'S JOB DUTIES
- TECH'S PRESENT KNOWLEDGE/SKILLS/CAPABILITIES
- MOTD REQUIREMENTS
- ADDITIONAL KNOWLEDGE/SKILLS/CAPABILITIES NEEDED BY TECHNICIAN
  - HOW CAN THESE BEST BE ACQUIRED?
    - MOTD ONLY?
    - TRAINING ONLY?
    - MOTD AND TRAINING?
  - WHAT FORM SHOULD TRAINING BE?
    - FORMAL TRAINING (NAVY SCHOOLING/LECTURE; SELF PACED/SELF INSTRUCTIONAL; ETC.)
    - INFORMAL TRAINING (SELF INSTRUCTION–SHIPBOARD; ON-THE-JOB TRAINING–BUDDY SYSTEM; ETC.)

Figure 3-1. Elements Inherent in the User-Data Match Strategy. The User-Data Match research issue will result in a methodology and set of guidelines for developing MOTD in its most useful form.

3.1.1.2 NTIPP APPROACH TO SOLVING THE USER-DATA MATCH PROBLEM

An effective, total solution to the User-Data Match problem cannot be achieved without undertaking a comprehensive and uniform approach which addresses all MOTD variables and problem areas equally and simultaneously.

Throughout current and proposed developments in TM systems there appears to be little evidence of a unified approach to solving the MOTD dilemma. Rather than applying human engineering principles to existing TM systems, most attempts at improving MOTD generally have focused on the piecemeal development of new products. As a result, a wide variety of innovative products have been generated; however, the majority of serious MOTD problems still exist.

The most widely used products developed thus far appear to be Functionally Oriented Maintenance Manuals (FOMMs), Job Performance Aids (JPAs), and Work Package (WP). (See topics 3.1.2.2, 3.1.2.3, and 3.1.2.4 for detailed discussions of these products.) Each seems to stress improved usability as the key to better MOTD. With this goal in mind, the developers of these and other products have concentrated on simplification of data presentation, uncomplicated arrangements, improvements in presentation/printing quality, easier access to information, improved readability/comprehensibility, etc. as ways of making MOTD more usable.

An analysis of current and proposed TM systems leads to the conclusion that, although each system has numerous merits and each improves MOTD to some extent, none of these products solves the entire gamut of problems associated with MOTD because each addresses only one or two specific system conditions or problems while ignoring others which may be of similar importance. An example of this phenomena was the development of FOMM. Functionally Oriented Maintenance Manuals are very well suited to the presentation of MOTD on electronic equipment/systems; however, to accomplish this the manuals must have physical dimensions considerably larger than those of conventional manuals. The result is that FOMM manuals are effective when they can be used, but often because of their size, many technicians find them difficult or impossible to effectively use due to environmental constraints.

Additionally, to date, most approaches to solving the MOTD problem have involved the use of one primary presentation technique and/or presentation media, such as the use of the JPA or FOMM technique, or the microform media for an entire set of documentation. NTIPP research concludes that a successful User-Data Match cannot be achieved in this manner. The use of several different presentation techniques and/or media must be considered in attempting to best match the user's characteristics to the MOTD he needs, within the realm of his environmental constraints. (This approach is consistent with the current NPRDC approach as stated in their NDCP[1] where they are attempting to identify optimum combinations/mixes of JPAs.)

Therefore, the NTIPP approach to solving the MOTD dilemma from a human engineering standpoint is one in which every attempt is made to simultaneously and equally address all existing and potential problem areas with respect to

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[1] Navy Decision Coordinating Paper, Program Element 63720N, ZPN58, 5 April 1976. Title: "Performance Aids Test and Evaluation."

the development of MOTD. It is felt that this approach is the only way in which an effective cure can be attained without the inadvertent creation of additional problems.

The NTIPP User-Data Match research will result in a model and set of guidelines which provide the framework for making the necessary decisions involved with the design and development of MOTD. The model will enable the developer to effectively match all the variables which are critical to the creation of a successful MOTD package. (These variables have been previously identified as the elements or components of the User-Data Match; see topic 3.1.1.1 for details.) This model will provide the theoretically best balance among all the variables. Additionally, since most MOTD is developed with numerous constraints already imposed upon the developer, the model will also enable the developer to make reasonable, justifiable decisions in light of imposed constraints.

The human factors firm of Anacapa Sciences, Incorporated is assisting the HAC NTIPP staff with the User-Data Match research issue. This research task centers around two main lines of analysis - the definition of candidate presentation techniques and media; and the determination of user requirements based on user characteristics, environmental constraints, equipment/systems definitions, job task analysis, maintenance philosophy, etc. The following is a summary of progress to date.

Selection of Ratings - To date, 32 Navy ratings and specialities within ratings (shown in Table 3-I) have been selected as a representative sample of various skills having a need for MOTD. Seventy-two Navy ratings were originally considered, and ratings which have little need for MOTD were eliminated, such as CS - Commissaryman, or DT - Dental Technician. Next, ratings which included operators only were eliminated. Investigation showed that these ratings have somewhat less need for MOTD than maintenance/operator or maintenance only ratings. Additionally, operator's MOTD tends to be less sophisticated and not as voluminous as other MOTD. Following this step, the ratings were compared to find which ones are highly similar in nature (have like job tasks). Therefore, some of these ratings were eliminated. This process resulted in a representative sample of 32 Navy ratings, 15 of which are from the "aviation trades" and 17 from the "seaborne trades". Included in the sample are the boilermaker and construction mechanic ratings which provide an insight into tasks which are less complex than those normally required for maintenance of electronic systems/equipment.

The first step was to acquire the array of skills and knowledges that each rating, specialty within rating, and rate should possess, from official Navy sources.[1] Using this information, a series of matrices were developed for each rating and rate. The purpose of developing these matrices was to determine if there is commonality in task descriptions for the 32 selected ratings. It was found that commonality in task description does, in fact,

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[1] Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards. Section 1: Navy Enlisted Occupational Standards, NAVPERS 18068D, September 1975.

3.1.1.2 NTIPP APPROACH TO SOLVING THE USER-DATA MATCH PROBLEM (Continued)

exist. Unfortunately, the topic and task descriptions contained in the aforementioned document are so general that they are virtually useless for further research purposes. It is anticipated that the research being done for NTIPP by Dr. Thomas Powers, University of Maryland, will add greatly to existing data on skills and knowledge.

TABLE 3-I. NAVY RATINGS SELECTED FOR CONTINUED USER-DATA MATCH ANALYSIS

	Rating*		Rating Specialty*
AIR	1.	Aviation Boatswain's Mate	ABE (Launching and Recovery Equipment)
AIR	2.	Aviation Boatswain's Mate	ABF (Fuels)
AIR	3.	Aviation Machinist's Mate	ADJ (Jet Engine Mechanic)
AIR	4.	Aviation Machinist's Mate	ADR (Reciprocating Engine Mechanic)
AIR	5.	Aviation Electrician's Mate	AE
AIR	6.	Aviation Structural Mechanic	AME (Safety Equipment)
AIR	7.	Aviation Structural Mechanic	AMH (Hydraulics)
AIR	8.	Aviation Structural Mechanic	AMS (Structures)
AIR	9.	Aviation Ordnanceman	AO
AIR	10.	Aviation Fire Control Technician	AQ
AIR	11.	Aviation Support Equipment Technician	ASE (Electrical)
AIR	12.	Aviation Support Equipment Technician	ASH (Hydraulics and Structures)
AIR	13.	Aviation Support Equipment Technician	ASM (Mechanical)
AIR	14.	Aviation Electronics Technician	AT
AIR	15.	Antisubmarine Warfare Technician	AX
SEA	16.	Boilermaker	BR
SEA	17.	Construction Mechanic	CM
SEA	18.	Data Systems Technician	DS
SEA	19.	Electrician's Mate	EM
SEA	20.	Engineman	EN
SEA	21.	Electronics Technician	ET
SEA	22.	Electronics Warfare Technician	EW
SEA	23.	Fire Control Technician	FTB (Ballistic Missile Fire Control)
SEA	24.	Fire Control Technician	FTG (Gun Fire Control)
SEA	25.	Fire Control Technician	FTM (Surface Missile Fire Control)
SEA	26.	Gunner's Mate	GMG (Guns)
SEA	27.	Gunner's Mate	GMM (Missiles)
SEA	28.	Hull Technician	HT
SEA	29.	Machinist's Mate	MM
SEA	30.	Missile Technician	MT
SEA	31.	Sonar Technician	ST
SEA	32.	Torpedoman's Mate	TM (Technician)

*From Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards. Section I: Navy Enlisted Occupational Standards, NAVPERS 18068D, September 1975.

TABLE 3-II. NAVY RATINGS CONSIDERED FOR USER-DATA MATCH ANALYSIS

Rating	Rating Specialty
1. Aerographer's Mate	AG (Weather forcasting)
2. Air Controlman	AC (Control tower operation)
3. Aircrew Survival Equipmentman	PR (Lifesaving equipment)
4. Aviation Antisubmaring Warfare Operator	AW (Flight crew special equipment operation)
5. Aviation Antisubmarine Warfare Technician	AX (Sophisticated detection equipment)
6. Aviation Boatswain's Mate	AB (Aircraft launching and handling)
7. Aviation Electrician's Mate	AE (Electrical)
8. Aviation Electronics Technician	AT (Aircraft electronic equipment)
9. Aviation Fire Control Technician	AQ (Aircraft electronic fire control equipment)
10. Aviation Machinist's Mate	AD (Aircraft engines)
11. Aviation Maintenance Administrationman	AZ (Administrative)
12. Aviation Ordinanceman	AO (Guns and missiles)
13. Aviation Storekeeper	AK (Aircraft supplies)
14. Aviation Structural Mechanic	AM (Aircraft Structure)
15. Aviation Support Equipment Technician	AS (Aircraft handling equipment)
16. Boatswain's Mate	BM (Master seaman)
17. Boilermaker	BR (Marine boiler maintenance)
18. Boiler Technician	BT (Marine boiler operation)
19. Builder	BU (Wood and concrete structures)
20. Commissaryman	CS (Food handling)
21. Communications Technician	CT (Specialized communication equipment)
22. Construction Electrician	CE (Power generation and distribution)
23. Construction Mechanic	CM (Heavy construction equipment)
24. Data Processing Technician	DP (Data processing equipment)
25. Data Systems Technician	DS (Computer systems)
26. Dental Technician	DT (Dentistry)
27. Disbursing Clerk	DK (Payroll)
28. Electrician's Mate	EM (Electrical)
29. Electronic Warfare Technician	EW (Electronic detection and navigation equipment)
30. Electronics Technician	ET (Electronic equipment)
31. Engineering Aid	EA (Construction)
32. Engineman	EN (Propulsion equipment)
33. Equipment Operator	EO
34. Fire Control Technician	FT (Electronic control systems)
35. Gas Turbine System Technician	GS (Gas turbine equipment)
36. Gunner's Mate	GM (Guns and missiles)

TABLE 3-II. NAVY RATINGS CONSIDERED FOR USER DATA MATCH ANALYSIS (Continued)

Ratings	Rating Specialty
37. Hospital Corpsman	HM (Medical)
38. Hull Maintenance Technician	HT (Metal work, construction, firefighting)
39. Illustrator - Draftsman	DM (Mechanical drawings)
40. Instrumentman	IM (Meters, clocks, office equipment)
41. Interior Communications Electrician	IC (Intercom systems)
42. Journalist	JO (Newspaper)
43. Legalman	LN (Law)
44. Lithographer	LI (Printing)
45. Machinery Repairman	MR (Machinery parts manufacture)
46. Machinist's Mate	MM (Machinery operation and repair)
47. Master-at-Arms	MA (Police and security)
48. Mineman	MN (Mine assembly and repair)
49. Missile Technician	MT (Fleet ballistic missile)
50. Molder	ML (Foundry)
51. Musician	MU (Music)
52. Navy Counselor	NC (Personnel guidance)
53. Ocean Systems Technician	OT (Oceanographic electronic equipment)
54. Operations Specialist	OS (Radar operation)
55. Opticalman	OM (Optical equipment repair)
56. Patternmaker	PM (Molding patterns)
57. Personnelman	PN (Personnel records)
58. Postal Clerk	PC (Mail)
59. Photographer's Mate	PH (Ground and aerial photography equipment)
60. Photographic Intelligenceman	PT (Topographical maps and intelligence reports)
61. Quartermaster	QM (Navigation)
62. Radioman	RM (Radio communications)
63. Ship's Service	SH (Laundry, barber, ship stores)
64. Signalman	SM (Visual signal equipment)
65. Sonar Technician	ST (Special ocean sounding devices)
66. Steelworker	SW (Heavy construction)
67. Steward	SD (Food Preparation)
68. Storekeeper	SK (Ship's supplies)
69. Torpedoman's Mate	TM (Torpedo-launching equipment)
70. Trademan	TD (Aviation training equipment)
71. Utilitiesman	UT (Water, light, heat, power and waste disposal equipment)
72. Yeoman	YN (Personnel administration)

3.1.1.2 NTIPP APPROACH TO SOLVING THE USER-DATA MATCH PROBLEM (Continued)

Listing of Personnel Characteristics by Ratings - With regard to identifying user personnel characteristics for each rating, reliance has been placed on three major sources: (1) a 1976 report by Dr. Powers,[1] (2) research currently being performed by Dr. Powers on this subject, and (3) a large amount of data being developed for NTIPP by the staff of the Navy Occupational Task Analysis Project (NOTAP). The information requested and supplied from NOTAP includes task inventories for each of the selected ratings which provide information on the equipment, tools, systems, and tasks performed by the technicians/operators within the rating. In addition, NOTAP is currently supplying computer runs which identify personnel characteristics peculiar to each rating. This data includes:

- GCT (General Intellectual Abilities) scores - mean and standard deviation
- ARI (Arithmetic Reasoning) scores - mean and standard deviation
- MECH (Mechanical Ability) scores - mean and standard deviation
- Amount of prior Navy schooling required to perform their jobs - mean and standard deviation
- Sources of individual's NECs (Navy Enlisted Classifications) ("B" school, "C" school, on-the-job-training, etc) - percentage of each source
- Sources of individual ratings - percentage of each source.

Compilation of Equipment Lists Related to Selected Ratings and Identification of Presentation Techniques - The equipment operated and maintained by the 34 selected ratings has been used as a vehicle for identifying specific types of presentation techniques used for conveyance of MOTD. The criterion used was that a given information presentation method should relate to a system, subsystem, or a specific piece of equipment. In addition, differences were noted in presentation media, manufacturers of system/equipment, and level of maintenance specified (organizational, intermediate, depot). An additional criterion governing the selection of appropriate maintenance information presentation methods was that the system should have an operational use expectancy well into the 1980s.

Review of Current Presentation Methods - The objective of this review was to isolate mutually exclusive categories so a taxonomy of presentation methods or techniques could be compiled. The taxonomy will then be reduced to components of presentation methods.

NTIPP documentation provided many examples of presentation methods. Unfortunately, direct comparison between sources was complicated by semantic problems in defining components. For example, what may be an illustration to some is a diagram, figure, drawing, or picture to others. Therefore, a listing of key presentation method descriptions was compiled. From the listing, a taxonomy of presentation methods was generated so that all terms could be operationally defined in mutually exclusive terms.

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[1]"Navy Enlisted Personnel Characteristics - Preliminary Analysis" - Man Tech Corporation, Rockville, Maryland, June 1976.

A checklist was compiled by components particularly applicable to those used in conventional formats, or "hard-copy" presentation techniques. The purpose of the checklist was to identify the specific presentation methods currently in use and to isolate the components of each method; for example, the presentation subsystems under the overall identifier of conventional methods such as standard formats, JPA, FOMM, and "hybrids." Components of the presentation methods include items such as type size, use of color, callouts on sheets, expanded diagrams, etc.

Field Test Checklist - The objective of this task was to evaluate the checklist before applying it on a large scale. The field test was conducted at the HAC Fullerton historical library on 14 manuals. The checklist proved effective in the categorical description of the presentation methods incorporated in the manuals. However, it was found that the subcategories of specific presentation techniques, such as FOMM, JPA, etc, did not fit the taxonomy well. Most of the presentation techniques in the manuals incorporated all, or a selection of, presentation components to clarify the point being described. As a result, the checklist has been modified.

Description of Work in Progress - Briefly, the work in progress includes the following tasks:

1. Continuation of the field testing of the list of selected equipment and accompanying documentation with appropriate specialists.
2. Examination of current presentation methods/techniques.
3. Development of microform checklists similar to the "hard-copy" one previously developed.
4. Development of a matrix showing presentation methods, by components of each method.
5. Compilation of a list of most promising candidate components, qualified by task and user. This list is to be a working tool and will be important to later phases of work.

Plans for Immediate Future - Following completion of tasks currently in progress, work will begin on the following:

1. Correlation of the results of Dr. Powers' data and NOTAP data on personnel characteristics of selected ratings.
2. Coordination of available information on the impact of the 1980s timeframe.
3. Development of matrices correlating personnel characteristics, fields of specialization (job tasks, equipment/systems, etc), environmental factors, and maintenance philosophies.

3.1.1.3 HEAD/DATA/TRAINING TRADE-OFF

The Head/Data/Training Trade-Off is the first critical step in using Human Engineering considerations to develop an integrated and effective equipment/system support program.

The Head/Data/Training Trade-Off is the process by which the critical decisions are made concerning how the user is to acquire the necessary data and skills to satisfactorily operate/maintain the equipment/system he must support. What does the user already know? What skills does he already possess? What additional data and skills must he acquire to successfully support the equipment/system? How much of such data and skills should he acquire through training, and how much through MOTD? These are the questions which must be answered during the Head/Data/Training Trade-Off.

As part of the Trade-Off, information must be gathered and assessed regarding each component of the Trade-Off: the "Head," the "Data," and the "Training." Considerations with respect to the "Head" are items such as:

- What amount of formal education has the user already obtained?
- What is his prior job experience?
- What Navy schooling has he completed?
- What are his general capabilities, such as ARI, MECH, GCT scores, etc?

With regard to the "Data," an assessment must be made concerning the total content of the data which will be needed to support the equipment/system. Also, human engineering considerations must be given to the ways in which all or specific parts of the raw data can best be transformed into usable MOTD. In other words, an analysis must be made concerning what form this data should take to be most usable. Would JPA be best, or FOMM? Or other?

Training* considerations should include:

- What portion of the data content could the user best acquire by training, and what portion by MOTD, taking cost into consideration?
- Will the equipment/system include automatic test equipment (ATE), built-in test equipment (BITE), or computer diagnostics? If so, this greatly impacts training <u>and</u> MOTD content.
- What types of training would be best for the user, taking user's capabilities and the costs of various types of training into consideration?
- What level of performance effectiveness is expected of the user?
- Can the MOTD be developed for use in training, or must separate training documentation be employed?
- How can the basic learning principles be systematically applied in designing and developing high quality training materials and MOTD?

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*Here, training is meant to denote Navy-sponsored efforts under CNET auspices, not in-house contractor efforts.

The last point mentioned above is a very important consideration. Since TMs are currently used in more than 2000 courses that train technicians to maintain specific pieces of Navy equipment, the needs of the training community must be addressed if a truly effective User-Data Match and Head/Data Training Trade-Off are to be achieved.[1]

If the training community is to obtain and use TMs that serve well as textbooks in maintenance courses, the unique requirements of training must be articulated. However, before this can happen the training community must do its homework - it must develop goals related to the design of MOTD; define and evaluate formats to be used in MOTD to improve learning; and determine whether the development of MOTD and Factory Training Materials can be better coordinated so as to produce more cost-effective materials for maintenance and training.

CNET should develop position papers, goals, and design requirements concerning the formats and content of MOTD. The type of information needed for maintenance training must be defined. This includes the topics to be covered and the level of detail required. The analysis would be part of a larger effort to establish policies governing the content of the various sources of information available to the technician - maintenance handbooks, rate training manuals, and factory training materials.

Formats that support specific types of learning tasks must be defined. Work Packages and JPAs provide step-by-step directions to guide the technician in performing a proceduralized task. However, in many situations it is necessary for the technician to recall a procedure which is merely cued by the job aid. In these instances, the technician needs learning aids in addition to job aids. Learning aid formats to support specific types of job tasks do not presently exist. These learning formats must be developed and validated.

Since MOTD and training documents are developed under separate specifications and by different branches in most contractors' plants, the MOTD and Factory Training Materials often do not complement each other well, are costly to produce, and are less than optimum in their usability. Improving the communication between those developing MOTD and those developing training materials may be possible through the use of the Head/Data/Training Trade-Off. During this Trade-Off, information that the technician must obtain from MOTD and that which must be recalled from memory during task performance are listed. With these lists, representatives from training and MOTD development can jointly determine the content and formats of their respective products.

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[1]Braby, Richard, Summary of (Training) Issues and Tentative Recommendations," Draft Issue, Training Analysis and Evaluation Group, Orlando, Florida, December 1976.

3.1.1.3 HEAD/DATA/TRAINING TRADE-OFF (Continued)

If training is to be an integral part of the development of successful MOTD, a representative of CNET should assist in the writing of the specifications to be used in procuring MOTD. In addition, CNET should participate in the in-process review and the verification stages of TM development when the TM is to be used in training. (Normally, the TM is the textbook in the maintenance-oriented "C" school.) Appropriate CNET activities should monitor the development of the MOTD at critical stages of development to ensure that what is produced is useful in maintenance training classrooms. The CNET representative should evaluate the documents for readability/comprehensibility, content required for training, accuracy of data, and utility of the formats as aids to the technician in learning that which must be recalled during job performance. Table 3-III lists basic learning principles that can be used in designing formats for MOTD that must be learned and later recalled.

Earlier, the point was made that if the equipment/system for which training/MOTD is being developed contains BITE, ATE, or computer diagnostics, this would greatly impact training and data content considerations. The requirement for built-in test equipment is derived from the mean-time-to repair requirements of the equipment/system. If BITE, ATE, etc., is present, the impact on MOTD/training design is significant in that it places a heavy requirement on the use of proceduralized troubleshooting coverage and expansion of text, flow diagrams, schematics, and illustrated parts breakdown to cover the BITE. Also, consideration must be given to the malfunction of the ATE or BITE itself. Should the technician be trained to deal with this? Should the MOTD cover this? If BITE is not present, obviously additional or different types of training/MOTD must be developed.

TABLE 3-III. BASIC LEARNING PRINCIPLES WHICH SHOULD BE APPLIES IN TRAINING/MOTD DEVELOPMENT

Objectives - Communicate goals to the trainee.
- -Tell the trainee what the outcome of his learning should be.
- -Provide criteria that the trainee can use to judge his own learning progress.
- -Describe the behavior expected of the trainee after learning the information.

Meaningfulness - Tie the unknown to the known.
- -Relate the information to be learned to (1) the trainee's experience, (2) the job for which he is gaining skills.
- -Relate the facts presented in the information to each other.

Mnemonics - Aid the recall of learned information.
- -Organize the material to facilitate the trainee's recall.
- -Generate mental images of things or events; use charts, pictures, and diagrams.

Attention-Getting Cues - Make the critical cues stand out in their context in the information to be learned.
- -Present the information which you want the trainees to notice in a manner that is relatively novel to them.
- -Vary your style and means of presentation from the usual.

Active Practice - Require overt responses. Trainees should:
- -Answer questions through writing or by making response aloud.
- -Organize or reorganize the information to be learned.

Feedback - Provide immediate knowledge of results within practice exercises. Feedback should:
- -Inform the trainee about his progress toward his objectives.
- -Be made available to him during learning so that he can identify and correct his errors.
- -Be given as soon as possible.
- -Can have reinforcing properties in that it serves to reward correct performance.

Whole vs. Part Practice - Cut the information down into learnable "chunks."
- -Break the information into smaller units to be learned when one (or more) of the following conditions exist in the learning situation:
  - Complex information
  - Large amount of information
  - Lower ability of the trainee

3.1.1.4 INITIAL REVIEW OF READABILITY

The apparent shocking discrepancy between "readability" of Navy MOTD, and the Navy technician's "reading ability" frequently reported in research reports, may be an artifact caused by incorrect applications of traditional readability tests and formulae.

As part of the User-Data Match Research Issue, an initial review and examination has been made of source material concerning readability of technical manuals related to reading ability of Navy technicians. "Readability" is defined as an attribute of written materials which refers to the ease of comprehension of subject matter by an individual. "Reading ability" is an attribute of individuals, and refers to a level of skill in comprehension of written materials.

Readability of Navy technical manuals is often expressed as the level of understanding of persons in reading-grade levels 11 to 15. Several studies testing the reading ability of Navy technical personnel found their reading ability (ie, reading grade level) is between 9 and 10.[1] These figures form the basis for the apparent mismatch between reading ability and readability. If one accepts these findings, he must infer that approximately half the Navy technical personnel cannot read/understand their technical manuals.

As an example, NAVAIR 00-25-700, Technical Manual Preparation Guide for Technical Writers, Editors, and Illustrators, defines more stringent readability requirements than any other Navy document. This document cautions that ". . . normally a sentence should not exceed 17 words"; and to ". . . avoid using words with more than two syllables whenever possible."

There are three considerations that may affect the mismatch between readability and reading ability: word length importance, reading-operation relationships, and additional interacting factors.

Most readability formulae are strongly weighted against the use of "difficult" words (ie, words outside the normal spoken vocabulary, or words of several syllables). An analysis of technical manuals showed the sample to contain approximately 15 percent technically-oriented words. These words are usually not used in the spoken vocabulary, and are typically polysyllabic, eg, "omnidirectional." Readability scores of material incorporating these words would lead to false assumptions of difficulty. Yet to the Navy technician, "omnidirectional antenna" is no more difficult than "big dog." Curran, Thomas, and Duffy suggested that "technical" words could be counted as simple words in readability formulae.[1] If the readability levels of technical manuals previously assumed to be between the 11th and 15th reading grade levels were reassessed on this basis, there may be dramatic changes in the "mismatch" levels.

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[1] Curran, T. E.; Thomas, G. S.; and Duffy, T. M. "Review of Technical Manual Readability and Comprehensibility," Naval Personnel Research and Development Center, San Diego, July 1975.

There is doubt regarding the value of applying reading ability and readability scores to Navy technical manuals. Virtually no data exists on the relationship of reading grade level (as measured on a standard reading test), and ability to actually use technical manuals in an operational situation. According to Githens, Shennum, and Nugent, "It may be that the skills that technicians use in working with the TM (eg, finding information, referring back and forth from equipment to text without strict time constraints) are different enough from those called for by a standardized reading test (eg, reading short passages quickly and answering questions on content) to render the test a doubtful prediction of a technician's actual ability to use the TM."[1]

Finally, the interacting factors of motivation, time, and clarity bear upon the readability issue. Reader motivation can certainly affect the amount of effort and attention a technician will put into comprehending a technical manual. His desire to understand the material, his interest in the content, and his familiarity with the subject matter are all important motivational factors.

Time to read the technical material is also a crucial factor. Reading grade level tests are timed tests and may not accurately reflect a slow reader's ability to comprehend difficult material provided it is presented at a rate with which he is comfortable. Probably having twice as long to read material will not give twice as much comprehension, but the exact relationship of time to comprehension of technical manual content remains unclear.

Reading grade level formulae are concerned with length and difficulty of words, and length of sentences. They do not concern themselves with the clarity of the prose. Thus, true readability may be affected by the clarity of the writing style, the clarity of the concepts being dealt with, and the clarity of the task-oriented directions given to the reader.

Readability metrics available at this time are restricted to text, as no usable measures of graphic comprehensibility have yet been forthcoming from continuing efforts in that area.

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[1] Githens, W. H.; Shennum, W. A.; and Nugent, W. A. "Personnel Characteristics Relevant to Navy Technical Manual (TM) Preparation," Naval Personnel Research and Development Center, San Diego, July 1975.

3.1.1.5 PSYCHOLOGICAL CONSIDERATIONS OF EXISTING AND PROPOSED MEDIA

Preliminary User-Data Match investigation indicates that little research has been conducted to date on the psychological implications of existing and emerging media, and the manner in which they are used to present MOTD.

Existing and emerging media may be used to present MOTD in various ways. Some of these media have stirred a great deal of controversy and discussion concerning their worth or effectiveness. Among the more controversial are microform, various forms of contemporary audio-visual techniques, interactive displays, and video disc.

As a whole, these media have unique characteristics which impact the degree of effectiveness with which a human being may use them. With respect to these characteristics, many questions should be answered, such as those shown opposite.

Answers to these and other questions must be acquired before these media can be confidently recommended for use in specific situations. Research is needed to determine the psychological impact each of these media (or components of these media) has on the learning process. Currently, we can only assume that interactive displays will aid the user in learning and performing job tasks; we can only guess about the value of using audio-visual media instead of conventional TMs for specific instances of MOTD documentation. Perhaps this research should be undertaken by the training community; perhaps a Media Laboratory should be established specifically for the purpose of evaluating existing and emerging media; or perhaps this research should be contracted out to an independent human factors firm. We can only emphasize the importance of acquiring this information as quickly as possible.

Some of this information has been obtained (and is now being obtained) by the method of implementing the media in the fleet and then waiting for feedback. This is a time-consuming and costly route to take, and results are often mediocre, biased, or inconclusive. With the advent of video disc technology we feel the need for this type of research and media evaluation is paramount. (See Topic 3.1.3.3 for discussion of Video Disc Technology.) Video disc appears to have many merits. It would be easy to fall prey to the contention that it may solve <u>all</u> MOTD problems, and that it is the "wave of the future." Video disc undoubtedly has a place in MOTD presentation; however, at the moment no one is sure exactly where that place is. Media research would give definite clues and information on how video disc could best be utilized.

An additional problem which must be addressed with respect to existing and emerging media is the issue of "equipment requirements." For effective utilization of a media, the equipment requirements inherent in the use of the media must be determined. When a media is chosen for the presentation of MOTD, consideration must be given to the need for viewers, etc. The cost of such equipment and the implications of not having the necessary amount of such equipment should be included in the analysis leading to the decision to

use a specific media. Exactly how many viewers or other pieces of media equipment are necessary in training and in the fleet operational environment must be determined. The training community can probably answer some of these questions; however, additional research like that proposed above will be needed if all these questions are to be answered.

TABLE 3-IV. QUESTIONS WHOSE ANSWERS MAY IMPACT THE DEGREE OF EFFECTIVENESS WITH WHICH HUMAN BEINGS USE VARIOUS MEDIA

- Does the data suit the media well, or is it a "forced fit?"
- How effective is the indexing system?
- Can the user control the speed with which information is retrieved and presented, or is the media more-or-less "lock-step" in nature?
- Does the media lend itself to ease of use in its intended environment?
- Can the user <u>control</u> the media in any way, such as with interactive displays?

3.1.1.6 USER-DATA MATCH ASPECTS OF CURRENT AND PROPOSED TM SYSTEMS

Based on results of the User-Data Match research, a set of guidelines for the development of human-engineered equipment/system support programs will be developed for incorporation into Data Acquisition rules and specifications. These guidelines will be the vehicle for ensuring that the Content Generator bases the design and development of all MOTD on sound human engineering principles.

The end product of the User-Data Match research will be a methodology or "model" and an accompanying set of guidelines which will enable the Content Generator to design and develop MOTD which is optimally matched to the needs and requirements of the user. Not only will this model be developed, but specific methods for applying it will be included. The model and accompanying guidelines will provide the framework for making necessary human factors decisions involved in MOTD development. This model will provide the theoretically best balance among all the variables, and additionally, since most MOTD is developed with numerous constraints already imposed upon the developer, the methodology will also enable reasonable, justifiable decisions to be made in light of the imposed constraints.

One of the major problem areas uncovered by the User-Data Match research is the overwhelming lack of human factors considerations found in most current and proposed TM specifications, policies, and procedures, and the cursory awareness paid to the user's data needs by the Content Generator. In addressing this problem, it became evident that the User-Data Match must specify the human factors considerations which should be incorporated into TM specifications, policies, and procedures. Additionally, it is imperative for the User-Data Match guidelines to specify the manner in which the Content Generator should develop his MOTD product from a human engineering standpoint, and specify the information the Content Generator must know in order to produce MOTD effectively matched to the user. It is important that TM specifications, policies and procedures provide explicit guidelines for implementation of the User-Data Match model or methodology by the Content Generator.

As part of the analysis of current and proposed TM systems, each system was analyzed from a human engineering point of view to determine what, if any, basic human engineering principles were evident, and to determine the extent to which each system addresses the elements which are incorporated into the User-Data Match methodology, such as personnel characteristics; environmental constraints; equipment/system considerations; etc. The analysis also included assessing the general merits and shortcomings of each system.

TABLE 3-V. CURRENT AND PROPOSED TM SYSTEMS ANALYZED FROM A USER-DATA MATCH VIEWPOINT

Current and Prior Systems analyzed:

- BAMAGAT (Block-a-matic, Block-a-gram, Block-a-text)
- SIMM (Symbolic Integrated Maintenance Manual)
- PIMO (Presentation of Information for Maintenance and Operation)
- Warrants Concept
- FOMM (Functionally Oriented Maintenance Manual)
- Work Package Concept
- JPA (Job Performance Aid)

Proposed Systems Analyzed:

- ITDT (Improved Technical Documentation and Training program)
- German IPB (Illustrated Parts Breakdown)
- U.S. IPB (Illustrated Parts Breakdown)
- DAPIL (Digital Assembly Parts Identification Lists)

3.1.2.1 PREVIOUS ATTEMPTS AT USER-DATA MATCH

Many research and development efforts have been expended on improved maintenance data and techniques, only to fall short because of a failure to address human factors considerations of User-Data Match, or the application of these considerations in only partial measure.

Only a few reports with in-depth treatments of human factors considerations for User-Data Match in military TMs are to be found. Until recently, terms such as user skill and educational profiles, motivation, task analysis, and like terms were not found in reports on innovative presentation techniques for maintenance. These words and connotations expressed therein were left to the psychological community. Of major importance to the NTIPP program is human factors research and the complex relationship between man and technical information.

This topic treats past and present studies and developments in the science of data presentation. Five techniques are reviewed, with an eye to User-Data Match considerations incorporated in their development or usefulness. Many of the reports reviewed for this topic were overly concerned with comparing their technique with something else, with sparse criteria given for the intrinsic worth of the proposed concept. Nevertheless, "between-the-line" information implied that the MOTD problems which most of the concepts intended to solve were:

- Effective use of low-skill personnel
- Reduction of training requirements
- Reduction in maintenance performance time
- Reduction in performance errors
- Utilization of data for training
- Improved access to information
- Reduced maintenance-induced damage to equipment
- Reduced manual size
- Uniform, reliable performance

Another very noticeable lack in many of the research studies on the development of formats and media is any concise statement of goals; how user-data match interfaces were to be developed; and structured, convincing approaches toward achieving these goals.

BAMAGAT/SIMM Concept - The Symbolic Integrated Maintenance Manual (SIMM) was developed by the Astro Division of Keltec Corporation, under the auspices of the old Naval Bureau of Ships. The original concept for the SIMM manual, however, was proposed by Hughes Aircraft Company under the registered trademark of BAMAGAT (Block-A-Matic, Block-A-Gram, Block-A-Text). The BAMAGAT manual concept utilized three unique illustration techniques to present the theory and functional structure of the equipment: the blocked schematic, the blocked text, and the blocked diagram. When the requirements for this type of presentation were formalized by the release of MIL-M-24100, the name was changed to SIMM. Over the next five years (1965-1969), the specification was

changed to MIL-M-24100A, a Writers' Guide was produced (NAVSHIPS 0967-077-5000), and two publications[1,2] were issued to authorize the use of SIM-type data for engineering purposes. The first of these publications requires engineering activities to provide the SIMM drawings, which can then be used in the maintenance manuals and be available early in a development program for evaluation of contract compliance. The second publication requires design engineers to make Maintenance Dependency Charts (MDCs), and then locate test points where the MDC shows they should be. Needless to say, neither of these ideas received wide acceptance, and the publications were added to the growing Navy inventory of "paper exercises." However, the SIMM approach to documentation was utilized by the Navy, Air Force, U.S. Post Office, Weather Bureau, and Federal Aviation Agency, and eventually evolved into Functionally Oriented Maintenance Manuals (FOMMs), which are discussed in more detail elsewhere in this section.

SIMM was a manual concept designed to reduce the complexity of technical information. SIMM pages varied in size (up to a maximum of 15 x 35 inches) but were usually larger than conventional manual pages. Normally they were in loose-leaf form, usually held together by ring binders. The main features of the SIMM technique are the blocked schematics, precise-access blocked diagrams, blocked text, and the maintenance dependency charts (MDCs). Both the blocked schematics and the precise-access blocked diagrams have facing pages of blocked text. The most important feature of the SIMM concept, from a User-Data Match viewpoint, is its MDC troubleshooting tool.

A complete description of the SIMM concept is included in MIL-M-24100. Briefly, SIMM contains all the information contained in a conventional manual, but presents it in a graphic form that is somewhat easier to understand and use. Like its BAMAGAT predecessor, blocking is used to depict system entities. Blocks are colored in shades of blue and gray to indicate functional and physical boundaries, respectively. Troubleshooting procedures are presented as a maintenance dependency chart (MDC). The MDC illustrates how events are processed throughout the system. Each MDC has three main areas, the procedures column (on the left), the heading (across the top), and the body. The procedure column outlines the turn-on and check-out steps which cause system events to be processed. Headings list the circuits which process the events and define the checkpoints at which other events that result from the processing occur (giving a specification or description of the event that appears there). The body to the right of each step in the procedure column gives the events that occur as a result of that step, and identifies the

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[1] MIL-HDBK-226 (Navy), "Design Disclosure for Systems and Equipment," Naval Ship Engineering Center, 17 June 1968.

[2] MIL-STD-1326 (Navy), "Test Points, Test Point Selection and Interface Requirements for Equipments Monitored by Shipboard On-Line Automatic Test Equipment, Naval Ship Engineering Center, 15 January 1968.

3.1.2.1 PREVIOUS ATTEMPTS AT USER-DATA MATCH (Continued)

circuits that must function properly for those events to occur. It is claimed[1] that as a result of this treatment, increased visibility is available to the technician, permitting more efficient troubleshooting of the equipment or system.

The presentation of troubleshooting information can take two basic approaches, decisional or nondecisional. Decisional aids, of which SIMM is a good example, give the trained technician a logical schema of equipment functions and inter-relatedness, and allow him to exercise his knowledge and experience to pinpoint the trouble. These are advantageous in that they allow entry into the system at any point, but a major disadvantage is the higher skill and greater training required to use them.

PIMO/JPA Concept - The project for Presentation of Information for Maintenance and Operation (PIMO) came about as a proposed solution to the problem of high support costs[2] on developing Air Force Systems. These high support costs were the result of a proliferation of complex hardware and information systems, with increased maintenance demands. The solution then was to use highly trained and experienced technicians which resulted in the development of specialists. Such specialization caused an increase in the number of personnel needed to maintain a system, poor cross-utilization of personnel, high training costs, and small productive output during the enlistment term.

This was the basic problem which Serendipity, Inc., was tasked to address by the Air Force in 1964. Their basic suggestions were directed not only at the change and improvement of documentation, but also at the areas of training, user attitudes and motivation, and manpower utilization. During the early phase of the study,[3] Serendipity defined the need for the application of job guide techniques (e.g., information developed along a task analytic approach), and a new formatting technique. In addition, it was felt that two modes of information presentation warranted testing (printed vs audio-visual).

The PIMO concept, a relatively simple but highly effective format for presenting maintenance instructions, enables an individual with very little experience or knowledge of aircraft or other equipment to efficiently perform both simple and complex maintenance activities. The format was designed to provide all the pertinent information for any given task, but no more. A task is defined as a short series of related actions, but not more than three. The

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[1]Singleton, N. E. and Pederson, E. L., "Technical Manuals Evaluation Program: SIMMS Format Versus Conventional Ordnance Pamphlet," Naval Underwater Weapons Research and Engineering Station, Newport, Rhode Island, August 1967.

[2]Lorenz, E. J. Col., USAF, "PIMO Type Job Performance Aids," Report No. 4185, Maxwell AFB, Alabama, November 1970.

[3]Inaba, K., et al, "Project PIMO Fina Report" (eight volumes), Serendipity, Inc., May 1969.

format also provides the information necessary to prepare for an activity (the input condition). The data is printed in small, pocket-size books which are easily carried to the location of the equipment.

An illustration of the particular equipment to be worked on, and a narrative of the actions to be performed, are used to present the total information relevant to a particular task. The illustration is used to present location information and to allow the user to relate the task instruction to the equipment upon which the action is to be performed. The pages are arranged to allow the user to have all of the information relevant to a particular activity located in one book.

The PIMO format was based on presentation principles derived from different types of research done at that time. Research on short-term memory was used to determine how much information should be presented in one task. Short-term is defined as 20 to 30-second intervals - about the elapsed time between reading the information and starting the task. Three separate but related steps represented the maximum number which, it was determined, could be retained without errors. (The maximum decreases when numerical information is involved, since this was shown to be more difficult to remember.)

PIMO utilized research on scanning to determine the amount of information which could be put on a page. Since the user is constantly switching from the instructions to the illustrations and to working, speed and accuracy of scanning to find the information needed is important. Research showed scanning time and errors increased considerably when the number of items researched exceeds seven. Multisensory presentation studies were also examined to help determine which information should be presented in narrative form and which should be presented in illustrative form. PIMO used a fixed syntax (common sentence structure) to help overcome the reading problem. The fixed syntax helped reduce the amount of interpretation required by the user, because of the inherent redundancy. A preferred verb list was used to ensure that the maintenance technician's language was used. This list was compiled from a survey of the potential users, both in training and in the field.

The PIMO concept was extremely simple, and therein was its merit. It presented information in a clear, concise manner and at a qualified level of detail. PIMO, more than BAMAGAT or SIMM at that time, concentrated more on the user-data interface in improving the technician's performance capability by providing information suitable for use on the job. While some pages of conventional and other forms of manuals have characteristics similar to those of PIMO, the big feature of the PIMO concept was that <u>all</u> of its pages were to have the same basic characteristics.

A review of the state-of-the-art of proceduralized troubleshooting indicated problems in the areas of flexibility, development cost, and user acceptance. Therefore, PIMO decided to use the Maintenance Dependency Chart (MDC) which had been in development under SIMM.

3.1.2.1 PREVIOUS ATTEMPTS AT USER-DATA MATCH (Continued)

Then came the trials of PIMO. The PIMO test was too broad, and tried to encompass the evaluation of too many items.[1] The test contractor was a small company that had never managed a large technical manual development/production program, and lacked the experience necessary to efficiently convert the C-141A (The test vehicle) manuals into the PIMO format. Their assumption (stated in meetings with Boeing personnel) that they could use nonengineering types with no direct link with the prime contractor's design personnel was not valid. This resulted in the generation of suboptimal test materials, and coupled with the test contractor's inability to produce viable measures of test results, no conclusive results were ever arrived at. Probably the best thing that came out of the PIMO episode was the resurrection of the "job-oriented" technical manual concept that had been tried and tested (but not vindicated) in the early 1950s on aircraft and missile programs.

Job Performance Aids (JPAs) provide specific procedurized maintenance information in relatively simple form. The format provides all the relevant information necessary to accomplish a given task, but no more. The tasks are presented in narrative form accompanied by highly illustrative line art. The narrative and artwork are arranged on facing pages to present the total task data with the greatest convenience factor. Maintenance tasks include such functions as inspect, service, remove/install, adjust and calibrate. The illustrations for each task provide location information, allowing the user to relate the task instructions to the equipment being serviced. All JPA tasks are developed to enable individuals with relatively little training or experience to efficiently perform simple and complex maintenance activities. With specific limitations, the JPAs can provide maintenance tools usable at all levels of maintenance. It is limited only by the ability of the user to perform specialized maintenance skills, or to operate sophisticated test equipment.

The JPA is best suited for mechanical applications, but is also applicable to electronic equipment. Electronic applications are lengthy, and require frequent assistance from specialist personnel. The cost in developing good JPAs is hidden in the many hours of research required to provide the necessary task analysis, human factors evaluations, action trees, and other essential prerequisites. The final product, though simple in appearance, is costly per page.

Though many research efforts are documented[2] in JPA technologies, the two types in much vogue today are termed Job Guides and Fully Proceduralized

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[1]Duren, D. R., "The Advanced Technical Data Research Study, Phase I, The Boeing Company, February 1975.

[2]Foley, J. P., Jr., "Hard Data Sources Concerning More Cost/Effective Maintenance," AFHRL-TR-76-58, ASD WPAFB, Ohio, July 1976.

Troubleshooting Aids (FPTA). Job Guides, like JPAs, provide instructions for fixed-procedure tasks such as checkout, adjustment, removal and replacement. The FPTA describes a method for isolating equipment malfunctions; wherein the selection and sequence of tests or checks is controlled by a preset procedure. The procedure is usually arranged so that the result of a specified test or check determines which test or other action is next performed. The number of branches or alternative checks at a choice point is typically two, but there may be as many branches as there are possible outcomes of the test.

The principle underlying the usefulness of proceduralized troubleshooting is simplification of the job through elimination or reduction of deductions, discriminations, interpolations and decisions which the technician would otherwise have to contribute. These are produced before the fact, and incorporated in the performance aids. When this is done, the technician need only "look up" the information he requires, instead of generating it himself. Since he is not required by the job to generate the information, he does not have to be able to do so. All information, both technical and that of a reasoning nature, are provided by the writer. The troubleshooting data is limited to the writer's maintenance experience and imagination. The user is not required to provide any creative reasoning, or to make any troubleshooting decisions independently.

This type of procedure provides very useful on-the-job training, but minimal retention of troubleshooting techniques. The user gains little analysis experience and very likely will not develop skills in this area except by repetitive task performance. The data presented is simple, convenient to use, and makes efficient use of the available personnel. It is highly effective when used with inexperienced or high turnover-rate personnel. For further discussion on JPA, see topic 3.1.2.4 of this report.

Warrants Concept - The warrants concept[1] utilizes a set of system conditions to invoke format-media features which are best suited to presentation information. Its basic premise is that developers of the multitude of innovative presentation techniques must necessarily have considered the alleviation of some troublesome system condition, and thus effected a better User-Data Match than existed before its development. Although the intent is good, the problem now is how to match the results of those good intentions with the proper system conditions. The system conditions encompassed by this concept are equipment, personnel, and environmental considerations. These are part of the present NTIPP User-Data Match conditions which also include format and media. The "warrants" concept plays the system conditions against format and media to arrive at the best User-Data Match mix.

A more recent report[2] which better describes the technique was released in November 1976. This report describes five steps in the selection method.

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[1] Post, T. J., "System Conditions Affecting Format and Media Used to Present Maintenance Information," BioTechnology Inc., 1 May 1975

[2] Post, T., H. Price, and G. Diffley, "A Guide for Selecting Formats and Media for Presenting Maintenance Information," BioTechnology, Inc., November 1976.

3.1.2.1 PREVIOUS ATTEMPTS AT USER-DATA MATCH (Continued)

The first step involves the gathering of information and generation of a Task Identification Matrix. Next, all maintenance actions (MAs) are grouped into three types - special case MA, troubleshooting MA, and remove/replace MA. These are further grouped into homogeneous sets prior to selecting formats and media. (MAs are considered to be homogeneous when they are of the same type, such as all troubleshooting, and are performed under the same system conditions.) Next, the best available formats are selected for each homogeneous set of MAs, and cost estimates are made for preparing information in the available formats. System conditions are then imposed to obtain the least costly and most effective format. Since the set of MAs in question is homogeneous, being performed under the same system conditions, this differentiation in selecting formats appears somewhat nebulous. The media is then selected in the same fashion. Nowhere in the guidelines do any instructions or procedures exist for actually conducting the "match." The "warrants" concept is in the developmental stage, and the developers recognize its limitations even in this stage. First, both the system conditions and their format-media features are tentative, meant only to illustrate the concept, and both the conditions and the format-media features require further development before they can be applied in even a test and evaluation situation.

TABLE 3-VI. SYSTEM CONDITIONS AFFECTING FORMATS AND MEDIA[1]

Task	Personnel	Hardware	Workspace
Troubleshooting Remove and Replace Testing Technique Special Case Actions • SOP • 1 Trial • Calibration • Hazardous • Periodic	Turnover Time to Proficiency Span of Supervision Personnel Qualification Standard General Classification Test (GCT) Job Scope	Automated Test Equipment Status Displays Distribution Readiness Impact Subordination Maintenance Demands Replication Installation Context	Illumination Space Elements (Rain) Cleanliness

[1]Post, T. J., et al, "A Guide for Selecting Formats and Media for Presenting Maintenance Information," BioTechnology, Inc., November 1976.

3.1.2.2 FUNCTIONALLY ORIENTED MAINTENANCE MANUALS (FOMM)

Functionally Oriented Maintenance Manuals (FOMMs) are the most recent step in an evolutionary process which began with BAMAGAT and SIMM. However, the lack of support life-cycle cost data for programs using FOMMs makes it impossible to determine if the high initial development costs are justified by decreased maintenance costs and increased operational readiness.

Military Specification MIL-M-24100B and writer's guide MIL-HDBK-242 provide guidelines for the planning and production of FOMMs. Normally a FOMM comprises two volumes, divided into multiple sections. Volume 1 - Support, contains the general characteristics and operational capabilities of the equipment, the operation instructions, the theory of operation, scheduled maintenance, installation instructions, testing procedures, and parts list. Volume 2 - Troubleshooting/Repair (T/R), contains a family tree equipment breakdown, a pictorial interconnecting cabling/piping diagram, a turnon/checkout chart, an overall functional diagram with keyed text and Maintenance Dependency Chart (MDC), blocked schematics with keyed text and MDC, repair/alignment procedures, parts data and wiring diagrams. FOMMs provide information to the level of detail sufficient to show the smallest functional entity. Additionally, a Technician's Pocket Manual (which is a photoreduction of the T/R Volume) may be procured.

From a user viewpoint the distinguishing features of a FOMM include its page size, which is usually larger than 8-1/2 x 11 inches. The primary method of communication is by diagram and pictorials, with the text used only to amplify what is shown pictorially. The manual is functionally divided so that all needed information for a certain job task is located in one area, and is usually self-contained on one page or two facing pages. Support information is contained in a separate volume, and presented in a conventional fashion. Troubleshooting/repair information is packaged separately, and uses fault isolation instructions in an MDC format. Color is limited to shades of gray and blue, with grays indicating hardware containment and blues indicating functional divisions. Finally, the troubleshooting/repair volume is structured to promote the maintenance philosophy of progressively eliminating portions of the equipment as the cause of an inoperative condition.

In contrast to the features of FOMM, the conventional technical manual usually has a page size of 8-1/2 x 11 inches or smaller, and uses foldouts. The primary medium of communication is by written word, with pictorials used to clarify the text. The manual is divided into sections either according to subject matter or to tasks to be performed. Color is seldom used. The manual is generally organized so that specific information needed by the user is often spread through several sections; thus, an extensive Table of Contents, List of Figures, and Alphabetical Index are required. Fault isolation is of the symptom/probable-cause/suggested-remedy type. Instructions are generally presented in tabular listing, "tree" charts, or logic diagrams.

3.1.2.2 FUNCTIONALLY ORIENTED MAINTENANCE MANUALS (FOMM) (Continued)

An analysis of the methodology used in the development of FOMMs reveals that while several User-Data Match elements are considered to some extent, many are not. As an example, system/equipment characteristics are considered, particularly from the viewpoint of methods of presenting physical and functional whole-to-part relationships. However, little emphasis is placed on personnel characteristics and task analysis. Military specification MIL-M-24100B indicates that as a general rule all FOMM equipment manuals shall be written to the level of writing of a high school graduate having specialized training as a technician in military training courses and having previous experience with similar or related equipment. Additionally, MIL-M-24100B states that considerations to be weighed in development of maintenance procedures shall include reliability, maintainability, simplicity, ruggedness, safety, and accessibility. These extremely general guidelines do not provide for adequate consideration of user personnel characteristics such as years of on-the-job experience, basic intellectual ability (arithmetic reasoning, mechanical comprehension, etc.), and reading ability; nor do they allow for task and environmental analysis which consider task complexity, criticality and frequency and environmental illumination, wind, noise, dirt, and work-space constraints.

Numerous research studies concerned with the evaluation of the FOMM have been conducted by the Coast Guard, Army, Navy, Air Force, Royal (British) Navy, Dustin Associates, Inc. (FOMM development specialists)[1], and an industrial ad hoc committee on service publications. These studies conclude that FOMM has certain advantages over conventional TMs such as reduction of training time, reduction of troubleshooting time when using MDCs, FOMM format is preferable to foldouts in most work environments, and FOMM is especially well-suited to the teaching of theory. However, a number of significant limitations and disadvantages have also been pointed out such as FOMM is basically oriented toward the support of electronic equipment only, need for additional information on how to use MDCs, problems in locating information, and problems concerning size. Additionally, these studies indicate that contractors "shy away" from FOMM, holding that the cost cannot be reliably estimated in advance (probably attributable to a lack of familiarity with FOMM development) and that there are few technical writers experienced in FOMM development.

The missing ingredient which is needed for an accurate evaluation of FOMM is reliable cost-performance/effectiveness data. This type of information would lead to a determination of the various sets of circumstances (equipment, environment, tasks, personnel) in which incurrence of the higher FOMM initial development costs would be justified by lower system/equipment support life-cycle costs.

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[1] Potts, Leslie L., et al, Comparative Analysis of Functionally Oriented Maintenance Manuals and Conventional Maintenance Manuals, Dustin Associates, March 1975.

TABLE 3-VII. DISTINGUISHING FEATURES OF FUNCTIONALLY ORIENTED MAINTENANCE MANUALS (FOMM)

- Communication by pictorial
- Larger page size
- Support information in separate volume
- Diagrams presented in a standardized fashion
- Use of color
- Troubleshooting/repair information in a separate volume formatted in a "general" to "detailed" manner
- Development and use of Maintenance Dependency Charts (MDC)

TABLE 3-VIII. SHORTCOMINGS OF FUNCTIONALLY ORIENTED MAINTENANCE MANUALS (FOMM)

- Generally oriented toward electronic equipment only
- Additional information needed on how to use MDCs
- Contractors shy away from FOMM because of difficulty in determining initial development costs; also, because few technical writers are experienced in FOMM development

3.1.2.3 NAVAIR WORK PACKAGE (WP) MANUAL CONCEPT

The NAVAIR Work Package (WP) manual concept is one of the most complete attempts to date at incorporating user-data match considerations into the preparation and formatting of TM's.

According to a recently published NAVAIR guide[1], "the Work Package (WP) manual is a series of small manuals or work units combined in one manual." The WP manual concept involves the arrangement of data according to functional tasks. These functional tasks (removing, testing, repairing, etc.) are then grouped into small units or packages. Ideally, each of these WPs is a self-supporting unit of information, containing all the data necessary for a qualified technician to perform a particular task. Only essential information is presented, and the technician needs no additional data with which to perform his maintenance tasks. The design of the WP manual is based on the needs of the maintenance technician, the medium of presentation used, and the projected educational profile of the technician. As stated in the same NAVAIR guide the objective of the WP manual is to "improve maintenance performance by simplifying format and increasing usability." The WP manual is designed for primary use on a microfilm medium and is limited to 30 pages of single-spaced text and illustrations per WP, although the preferred optimum amount is 12 to 15 pages.

The basic difference between WP and conventional manuals is the WP organization of data. WP manuals are usually arranged by maintenance level or equipment-oriented groupings. The organization of data, while containing benefits for the user, is also necessary for the microform medium for which most all WP manuals are structured. Though many conventional manuals are prepared to be microform-compatible, WP manuals are almost exclusively prepared for microform. Another apparent difference between WP and conventional manuals is the manner in which the data is prepared for WP manuals. WP manuals prepared to recently released requirements involve the generation of a Task Identification Matrix (TIM) and the use of task analysis in the preparation of procedural data. Chapters of the new guide (NAVAIR-00-25-700) also contain writing and illustration guidelines, as well as text and graphic comprehensibility assurance criteria. Because WP manual organization stresses the consolidation and assembly of data in its most usable form, it is not to be suggested that manufacturers of conventional manuals do not attempt the same within the confines of applicable specification requirements. If the full letter of the requirements contained in the new guide is adhered to, the difference between new WP manuals and the conventional TM will become very broad. Additionally, this document appears to redirect the historical role of the TM writer to the development of those functions and products of LSA of which he has had little past experience. The guide is much more definitive in scope and purpose than any WP oriented TM specification in existence.

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[1] NAVAIR 00-25-700, "Technical Manual Guide for Technical Writers, Editors, and Illustrators," 1 June 1976.

NAVAIR has four primary TM content specifications which provide for the generation of WP manuals - MIL-M-81701, 81919, 81927, and 81929. These specifications are all microform-compatible, and use the general microform preparation specification, MIL-M-81927, for general requirements. NAVAIR has been buying TMs built to the requirement of these specifications for the past several years. The new guide which NAVAIR is in the process of publishing is intended to assist writers, editors and illustrators, to "aid them in understanding and complying with new and innovative techniques and requirements" for WP manuals. This guide is intended to be used with all approved NAVAIR TM specifications which it lists in an Appendix A. The guide then proceeds to discuss NAVAIR TM specification by stating they "can be used only for inspection and acceptance by quality control personnel, rather than as a detailed development guide for the preparing activity. This failure to provide detailed preparation policies and procedures has given the technical writer excessive latitude in writing style, and the illustrator only vague guidelines as to what constitutes a well-planned illustration." It is also indicated that, "a major drawback in the use of any specification is that while it directs the quality of the product, it also restricts incorporation of improvements that were not anticipated when the specification was prepared." In spite of these somewhat contradictory statements, this document contains many items of merit from a User-Data Match viewpoint.

One of the major benefits of WP manuals is the organization of data into usable, bite-size chunks. This is almost compulsory in a microform medium. The guide gives better criteria and steps necessary to do this for NAVAIR WP manuals than existing WP-oriented TM specifications. In fact, this was the most significant User-Data Match consideration contained in any of the WP-oriented TM specifications. The generation of the types of WP materials in the order indicated does not necessarily guarantee a User-Data Match. The proof of how effective the new guide will be in aiding WP manual development and use will be seen in future WP manuals bought by NAVAIR. It will be necessary for NAVAIR to continue the development and implement means to access the WP impact on user performance.

3.1.2.4 JOB PERFORMANCE AIDS (JPA)

During the late 1960s and early 1970s, the JPA concept was proclaimed as the answer to the operator/maintenance problem. Developmental efforts have continued to the present in an attempt to perfect the JPA concept; however, evidence indicates that JPAs are not as advantageous as originally thought.

Basically, the Job Performance Aids (JPAs) tell a user how job tasks are to be accomplished. The JPAs are step-by-step instructions intended for use in the performance of maintenance tasks. These instructions are accompanied by detailed illustrations which show the user what the components referred to in the instructions look like, and where they are located on the equipment. JPAs are based on data from a complete, detailed task analysis on the equipment and the user's job duties. JPAs are designed to provide, in one place, all the information the user needs to perform his job.

The fundamental premise behind the Job Performance Aid is that it is possible to simplify a job, and reduce the cognitive skills required to perform it, to the extent that anyone can successfully complete the job tasks if enough specific information is provided which is written to the intellectual level of the user. Normally, when a technician is assigned to do a task he must decide what tools to use, what actions he must perform to accomplish the job, and in what sequence the job tasks are to be performed. In the JPA, this information is incorporated into the instruction; therefore, the user need not generate that information, and less-skilled, less highly trained users can perform the job tasks. Some JPAs are called "Fully Proceduralized" (FPJPAs). These extend the job guide concept to cover troubleshooting tasks. They provide complete, step-by-step procedures for the isolation of malfunctioning components. These aids are designed to isolate all specified malfunctions at a given level of maintenance.

Conventional technical manuals are aimed at a user audience presumed to be somewhat more sophisticated in relevant technology and more familiar with the equipment than is presumed of the JPA user. Conventional technical manuals place major emphasis on description of the equipment, whereas the JPA focus is on instructions for the performance of user job tasks. JPAs generally include equipment descriptive information only in specific places, and then only to the extent required in connection with performance of specific steps in specific tasks.

Theoretically, the JPA is designed to be perfectly "matched" to the user's capabilities. This is one of the JPA's most proclaimed attributes. During development, specific assumptions are made by the JPA contractor and the Procuring Agency about the user's capabilities, skills, knowledges; the JPAs are then developed and written to this level. It is important to note that if the capabilities of the JPA user are overestimated, the users will not be able to use the JPAs.

As can be seen in the accompanying table, JPAs have many significant attributes. When they are successfully developed and used they are almost foolproof, resulting in higher task performance reliability; they are more cost-effective than conventional TMs; they reduce manpower requirements and

training time; they decrease dependency upon personnel of high aptitude, and facilitate the transfer of maintenance personnel from one system to another.[1]

However, from a practical viewpoint JPAs have several serious shortcomings. Frequently, they are not successfully matched to user capabilities; they are very expensive to develop because they frequently require repeated major revisions of the material before it is usable; JPA-trained individuals cannot compete competitively on the military career progression ladder due to their lack of basic knowledge; and JPAs are generally ineffective for troubleshooting of complex electronic equipment.

The most serious shortcoming of the JPA is its critical susceptibility to errors in the data base. While such errors introduce difficulty in using MOTD in any format, the JPA product is rendered virtually useless thereby.[1] An outstanding example of this is found in the USAF report, Job Performance Aids of the UH-1H Helicopter, Controlled Field Tryout and Evaluation.[2] It is stated that "the original fully proceduralized JPAs, both troubleshooting and nontroubleshooting, were virtually unusable, primarily because of many errors in the data base." The index to the JPA was not usable. Although technician performance in both troubleshooting and nontroubleshooting tasks was somewhat improved using the JPAs and FPJPAs, these results were not accomplished until after the third major revision of the materials. It should be noted that this does not render the JPA approach invalid per se; however, great care is required to avoid errors in the data base because the nature of the JPA product can easily be rendered unusable due to incorrect data.

Opinions on the merits or deficiencies of JPAs vary widely. However, most critics admit that there is definitely a place in the world of technical documentation for the JPA, but it cannot be "all things to all people."

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[1] Joyce, R. P., et al, "Fully Proceduralized Job Performance Aids: Handbook for JPA Managers and Training Specialists," Applied Science Associates, Inc., December 1973.

[2] Shriver, Edgar L., "Job Performance Aids For UH-1H Helicopter: Controlled Field Tryout and Evaluation," URS, Matrix Research Co., June 1975.

3.1.2.4 JOB PERFORMANCE AIDS (JPA) (Continued)

TABLE 3-IX. ATTRIBUTES AND SHORTCOMINGS OF JPAs

Attributes:

- Theoretically foolproof, resulting in higher task performance reliability
- Theoretically more cost effective than conventional TM systems
- Reduce manpower requirements
- Reduce training time
- Decrease dependency upon personnel of high aptitude
- Facilitate the transfer of maintenance personnel from one system to a different system.

Shortcomings:

- Often not successfully matched to user's abilities
- Errors in data make JPAs unusable
- Development of fully proceduralized JPAs very expensive
- JPA-trained individuals cannot compete on military career progression ladder
- Large quantity of data needed to accomplish a given task

3.1.2.5 USER-DATA MATCH ASPECTS OF MICROFORM

Microforms were originally developed for data storage purposes. Use of this powerful medium for MOTD presentation has not been totally effective due to inadequate consideration of its unique characteristics and their impact on the user.

Microform use within the military is best characterized by three major projects: (1) the Maintenance Information Automated Retrieval System (MIARS) developed by NAVAIR, (2) the Technical Manual Microfiche Program developed by NAVSEA, and (3) the Technical Order Microfilm System (TOMS) developed by the U.S. Air Force.

Briefly, MIARS can be described as an automated data storage, retrieval, and presentation system using 16mm cartridge film. It consists of an automatic search control console to retrieve desired information and a reader/printer to print paper copies of selected maintenance data. The NAVSEA microfiche system is simply a basic microfiche viewer/printer which uses individual fiche containing up to 98 pages of data each. The Air Force TOMS was a program to microfilm organizational (10-level), intermediate (20-level), and depot (30-level) technical orders (TOs) using 16mm microfilm.

Initial Navy studies and surveys indicated that use of microform in Navy technical documentation was generally well accepted by the users of those systems. The findings of the MIARS Task Force Report[1] point out that "all squadrons reported that MIARS had helped in maintaining the aircraft and had provided quicker access to maintenance information," and that "significant benefits were gained in operational readiness." This survey also indicated that the majority of technicians thought "the information was presented in a more usable format, much easier to understand." The comparable report on the NAVSEA microfiche effort[2] also refers to widespread user acceptance of microfiche.

Apparently, due to more widespread application of microform throughout the fleet and a more intensive investigation, the technicians' attitude today concerning microform is quite different from that voiced initially. The HAC NTIPP Fleet Survey's preliminary data indicates there is considerable dissatisfaction with the microforms currently used in the fleet.[3] Table XI lists the major disadvantages of microform (not necessarily MIARS in particular) as primarily cited by users.

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[1] "MIARS Task Force Report on Fleet Test and Evaluation of 16mm Microfilm System for Aircraft Maintenance Manuals," Naval Air Systems Command, November 1970.

[2] Plan of Action and Milestones for the Implementation of NAVSEA Technical Manual Microfiche Program, Naval Sea Systems Command, November 1975.

[3] This survey effort will be documented in a separate Hughes report to be issued on 5 March 1977.

Some of the user dissatisfaction may be due to the fact that initially conversion of earlier generation TMs was "forced"; more recent conversion of TMs followed specifications designed for that purpose, and the end products appear to have resulted in greater user approval.

The survey also showed that the majority of technicians familiar with MIARS thought it was well suited for parts and supply system ordering.

Contact with the U.S. Air Force concerning an evaluation of their TOMS program revealed that the entire microfilm program had been cancelled. The primary reason for cancellation of the program was that, upon evaluation, it was found that a large majority of the microfilm users were converting the microfilm back to paper copy before performing their job duties. Thus, since the intent of the program was to eliminate paper copy as much as possible, it was determined that the TOMS program was not accomplishing its goal, and was therefore cancelled.

At a NATSF conference in Philadelphia on 12-14 October 1975, COMNAVAIRPAC recommended retention of paper versions of technical manuals which had been converted to microform under the MIARS program, until persistent problems with reader/printer equipment had been resolved. As a result, NATSF placed a moratorium on eliminating paper TMs in this category. The moratorium has since been removed, in view of NAVAIR's efforts in reader/printer improvement, particularly in the development of a lightweight portable reader. Current work is progressing well on fixing the frame-to-frame continuity problem concerning printing of continued diagrams; a survey is being performed to establish which TMs are compatible to microform; and research is being done concerning the problem of data access or the indexing of microform. NAVSEA will be using filmstrip to teach the use of microfiche.

In general terms, comparison of microform with conventional paper technical documentation indicated the primary advantages are that microform can be <u>updated simply and rapidly</u> with regard to posting changes. The time and <u>cost of distributing microform</u> is <u>significantly less</u> than shipping paper manuals. There is a considerable reduction in required library and storage space. Microform production time and costs are less than for printed copies. Microform eliminated the problem of inserting change pages at the maintenance level resulting in integrity and currency of information. Microform, if properly indexed, can improve retrieval and presentation of information, and the distribution of microform can be centrally controlled.

In general, the principal disadvantages to the use of microform include the need for better indexing methods; the quality of the microform product is often unsatisfactory; better provisions for the control and handling of classified data need to be developed; retrieval equipment must be redesigned to meet military environmental requirements to eliminate or decrease downtime; no capability exists to offer a foldout drawing on the microfilm reader at one time; the microform user cannot have simultaneous reference to several pages as with a conventional manual; frame-to-frame correlation in continued diagrams is often lacking; and a shortage of microform readers usually exists aboard ship. There is also a need for an effective logistics support plan to be developed for retrieval equipment, such as a maintenance plan and inventory of spare parts, etc.

3.1.2.5 USER-DATA MATCH ASPECTS OF MICROFORM (Continued)

Additional research and experimentation are necessary to perfect microform systems before any final evaluation can be made on its worth for the presentation of MOTD.

TABLE 3-X. ADVANTAGES OF MICROFORM OVER CONVENTIONAL PAPER MOTD

- Microform can be updated simply and rapidly
- Distribution costs are significantly less than for paper TMs
- Considerable reduction in library and storage space with microform
- Microform production time and costs less than printed copy
- Microform eliminates problem of inserting change pages at maintenance level resulting in better integrity and currency of information
- When properly indexed, microform can improve retrieval and presentation of information
- Distribution of microform can be more easily centrally controlled relative to hard copy

TABLE 3-XI. DISADVANTAGES OF MICROFORM COMPARED WITH CONVENTIONAL PAPER MOTD

• Many times, workspace constraints make microform impractical or inaccessible • There is need for better indexing methods • Provisions for control and handling of classified data need to be perfected • There is need for foldout drawing capability • Frame-to-frame correlation in continued diagrams needs to be improved • There is need for an effective logistics support plan for retrieval equipment • Cannot handle wiring diagrams • Color coding is lost • Photos are often indistinguishable • There is need to eliminate excessive downtime - retrieval equipment must be redesigned for military use and made more rugged • There is need for a smaller, more compact, lightweight unit • Most technicians feel training to use microforms should always be taught in "A" school because it is critical information. (This training is currently taught in some "C" schools)

3.1.2.6 USER-DATA MATCH ASPECTS OF LOGISTIC SUPPORT ANALYSIS

Logistic Support Analysis (LSA) as specified by DoD Standard MIL-STD-1388 (used by all services) provides some guidelines for consideration of a number of factors critical to matching MOTD to its users. However, in the current system, even this limited attempt at a user-data match is often not implemented.

LSA as defined by MIL-STD-1388 identifies all support requirements such as maintenance planning, support and test equipment, supply support, transportation and handling, technical data, facilities, and personnel and training for a system or equipment, as well as establishing and monitoring a balance between design and maintenance requirements. A contractor-performed LSA of procuring activity inputs, and government and contractor functional elements provided quantitative and qualitative data describing personnel and support requirements, are used by the content generator to match the MOTD being developed to the user. Procuring activity inputs that affect MOTD include such items as operational requirements, special constraints, long-range maintenance, maintenance support concept, existing technician skills and environmental considerations. The government and contractor functional elements considered for MOTD include technical publications details, engineering drawings, specifications, reliability and maintainability predictions, milestones, test results, and operator and maintenance task analysis data. Outputs of the LSA are quantitative and qualitative data specifically identifying and describing such items as personnel requirements by skill, type and number; support and test equipment; spares and repair parts; and facilities. Without the results of the LSA, the content generator has to rely on his technical and MOTD development experiences, data acquisition rules (CDRLs, DIDs, TMCRs, specifications, standards), and his understanding of the user environment and needs to match the MOTD to the user.

Computer processing of the LSA data sheet outputs supply the Maintenance Allocation Charts (MACs) provisioning lists, tools and test equipment, training requirements, etc. in the form of individual LSA records (LSARs). The LSAR data content is determined by customer developed computer facilities (although it could be manual, automated, or hybrid), to meet customer determined support data requirements. The content generator must extract information needed to develop MOTD from the various LSARs or from the data sheets themselves if the customer performs the computer processing. For example, in implementing MIL-STD-1388 data is extracted as follows: (1) data sheet A defining operations and maintenance requirements for the end item and major subsystems provides the content generator with the maintenance concept; (2) data sheet B containing reliability and maintainability data provides failure modes, symptoms and effects for troubleshooting purposes; (3) data sheet C containing a task analysis defines operator and maintenance task descriptions, skill specialty codes, task times, personnel requirements, and support and test equipment; and (4) data sheet D containing a maintenance and data analysis provides step-by-step maintenance procedures.

In the NAVSEA Trident program, the Navy developed customized Integrated Logistic Support (ILS) specifications and procedures (NAVSEA 0905-501-7010, ILS Master Plan and NAVSHIPS 0900-061-5010, LSA Procedures Manual) based upon MIL-STD-1388 to provide an LSA which would meet the support requirements

peculiar to the submarine service. The resultant LSARs supplied basically the same data required by MIL-STD-1388 only in the form of Maintenance Repair Cards (MRCs), Maintenance Parts Lists (MPLs), tools and test equipment, consumables, etc. However, the content generator's extraction process required to obtain information needed for MOTD development remains the same, no matter which type of LSA effort is performed.

The amount of LSA data available and its value to the content generator depends upon the level of LSA that is procured as shown on the facing page. In the case where a fully implemented LSA is performed in accordance with all the requirements of MIL-STD-1388 and is performed concurrent with all phases of engineering concept, design, and development, the resulting output provides the content generator with much of the data required to match the MOTD to the user. However, a fully implemented LSA raises program procurement costs significantly.

To reduce procurement costs, a limited LSA is frequently procured and the maintenance concept is specified in the contract statement of work. For example, in the NAVELEX Surveillance Towed Array Sensor (SURTASS) program, the LSA is performed during the engineering concept and development model phases. Under these circumstances, LSA data for use by the content generator is limited and does not remain current because of changes occurring during the final design and production phase. The content generator has to rely on his experience and understanding of the maintenance concept to match the MOTD to the user.

In another limited LSA effort (NAVELEX Design-to-Price Electronic Warfare program), the LSA was a full effort but was, in essence, terminated after the first analysis and development of LSARs. Consequently, the content generator could not track the impact of engineering changes on maintenance procedures in a timely manner, increasing MOTD costs and limiting the content generator's ability to match the MOTD to the user. If a one-time LSA effort is procured, the LSA is usually performed at the end of the design phase, and prior to or concurrent with the production phase in order to provide accurate provisioning data. In this case, MOTD development and the LSA effort are performed concurrently, providing little if any usable LSA information to the content generator. From the above, it can be seen that the amount of usable information provided by the LSA to the content generator is dependent upon the type of LSA selected for a program.

A major problem of the LSA which decreases its usefulness in MOTD development is its costs. In many cases, the major portion of the procurement dollars are allocated to the purchasing of additional hardware rather than a fully implemented LSA. Often, where procurement funds are limited, a tradeoff is made between procurement of an extra piece of hardware and a fully implemented LSA - with the results usually favoring the additional hardware. Reducing the size of an LSA effort reduces or negates its positive impact on the user-data match, and at the same time increases MOTD development costs. Consideration of this impact of LSA on the MOTD user-data match and MOTD costs as well as LSA impact on the other support activities (training, provisioning, etc) should be one of the determining factors in the selection of the level of LSA to be procured.

3.1.2.6 USER-DATA MATCH ASPECTS OF LOGISTIC SUPPORT ANALYSIS (Continued)

TABLE 3-XII. COMPARISON OF LSA IMPACTS

Type of LSA	MOTD Related LSA Output	Impact on MOTD User Data Match	Remarks
Fully implemented	Large continuously updated maintenance data base	Maximum value	No LSAR programmed for MOTD use, requires manual data extraction
Limited	Varies from large to limited maintenance data base with limited number of updates	Minimal value	Depth and accuracy of data limited to number of LSARs and their update cycles
One-shot	Limited maintenance data base with maximum of one update	Little or no value	LSA data availability is too late to impact MOTD development

3.1.2.7 USER-DATA MATCH IMPACT ON DATA ACQUISITION

The results of the User-Data Match research issue will impact, directly or indirectly, many NTIPP issues. One of the largest impacts is on data acquisition and the human factor considerations which it must reflect in TM acquisition specifications, policies, and procedures.

Data acquisition involves the management of technical manual procurement and maintenance processes and the formulation and propagation of those devices (specifications, standards, guides, policy and procedure documents, etc.) by which the process is implemented. The primary objective of data acquisition is to provide to the content generator (whether a contractor or a Navy in-house activity) a precise set of guidance documents to govern the manner in which that content generator develops his product. Data acquisition must be able to specify what the Navy needs, exactly what it is buying, how much it is costing, and to be able to monitor and verify the quality of the MOTD product throughout its development. Data acquisition must exert continual effort to ensure that the guidance it is providing through its influences on the technical data system is not producing untimely, static and poor-quality products.

Impact on Specifications - The most significant impact of User-Data Match research on data acquisition is in the area of TM specifications. It is through TM specifications that these impacts are then transmitted to the content generators. Specifications indicate to the content generator the types of technical content which are to be prepared for a particular skill level, equipment type, and the formats and media by which it is to be prepared. In the past, the TM specification factors which have received the most attention with respect to User-Data Match considerations are format and media. This has resulted in restructuring the data in the TM for greater user ease and providing it to the user on hard copy or microfilm.

Lack of Present Provisions - The ideal User-Data Match is a combination of various personnel characteristics, equipment types, job tasks, environments, formats and media which are proportioned in the proper mix to produce an optimum TM product. There are presently no TM specifications in existence, nor guidelines for preparing them, which come close to approximating the ideal situation of a User-Data Match in defining the development of a TM. Although some TM specifications address one or two User-Data Match considerations, such as level or depth of writing and structure of information content, it is not feasible that these same TM specifications could be used for every category of TM for every possible type of equipment, and effect any kind of a User-Data Match in every instance.

Absence of Head/Data/Training Tradeoffs - In the present review of data acquisition policies and procedures a significant lack of head/data/training tradeoff considerations were exhibited. This tradeoff refers to the decision concerning the amount of material that must be trained into the "head" of the trainee, as contrasted to the amount of information that can be presented to him via the "data". Analysis of the "working philosophy" of both the technical manual and technical training fields indicates that each "camp" is not really interested in the requirements of the other camp or in the coordination of objectives in a common cause. Each is more often than not overpowered with

the ultimate concerns of getting on with their individual chores. Many highly dramatic cost benefit studies in maintenance have been performed in each camp but researchers in the respective groups appear to be functionally ignorant of each other's advances. The feeling in the TM community appears to be that prescriptive guidance is so cost-effective that the "head," or training side of the tradeoff can be largely ignored. The technical trainers seem to believe that maintenance simulation is so cost-beneficial that the "data" side of the tradeoff can be ignored, since hands-on experience will always be required and TMs are only incidental. There are, of course, dangers in both provincial points of view, not the least of which are (1) the possibility of creating an entire community of technicians who can troubleshoot only those exact faults which are prescriptively guided by the book, or (2) the likelihood that even the best findings of the two-dimensional TM media will be completely ignored by the training community and thus not find their way into possible interactive computer-aided instructions of the future.

Inadequacy of Interfaces - Traditionally, developers of both military and civilian maintenance training have played little or no role in the selection of TM content and type of presentation. Likewise, TM developers have frequently been insulated from the formulation of training programs by organizational discontinuities, military policy and procedures, and specifications. With the advent and use of integrated logistic support (ILS) concepts in system development, increasing numbers of military and civilian organizations are at least recognizing the reasonableness of the integrated TM and training approach to support for maintenance. But, before this happens in actual practice, many attitudes in both the training and technical manual camps must change. Policies, procedures and specifications used by the two camps in procuring their products will have to show some degree of compatibility.

Need for Improvement - In general, present trends in data acquisition reflect too much outdated thinking in regard to TM documentation. TMs have been acquired and manufactured in essentially the same way for the past 50 years because of established precedents which for the most part have gone unquestioned. Things would probably still be in fine shape if the technology and complexity of equipment had not outstripped the ability to support it with suitable documentation. The need exists now, more than ever, for human factor User-Data Match considerations to be effectively applied in the future development of MOTD and in the data acquisition processes.

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SYSTEMS AND FEASIBILITY TRADEOFF ANALYSES. TASK 1. ANALYSIS OF --ETC(U)
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UNCLASSIFIED FR-77-12-332 NL

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3.1.2.8 USER-DATA MATCH IMPACT ON CONTENT GENERATION

User-Data Match principles should be a major consideration in the design and development of MOTD by the content generator. However, in the current TM system the content generator exhibits minimal awareness of the user's data needs.

The content generating activity is normally a contractor for new MOTD; however, it may also be the military agency in-house capability. From the contractor's standpoint, the process of developing MOTD content is essentially the same whether dealing with the three Navy System Commands, the Army, or the Air Force. This function is responsible for collecting the data, preparing technical publications planning documents, writing the TM, critiquing the TM and performing validation. Guided by the data acquisition rules, the content generator performs the human transformation of the engineering/manufacturing/maintenance data bases into MOTD. As a result of human involvement, the transformation output is subject to interpretations, biases, inadequacies, and errors. The quality and quantity of the output is both time and dollar constrained.

The most critical inputs to the content generation function are the engineering/manufacturing/maintenance data bases and the data acquistion rules which should provide guidelines for performing the user-data match and head/data/training trade-off. Content generating activities are divided into prewriting tasks consisting of MOTD proposal preparation and development of publication planning documents; writing tasks during which original MOTD is generated using TM presentation techniques handbooks and writers' guides for readability and comprehensibility (text and graphic); and postwriting tasks during which MOTD maintenance is performed.

Traditionally the contractor content generating activity has exhibited little or no awareness of human engineering considerations in the design and development of MOTD. Few if any military contractors currently employ personnel skilled in the human engineering of MOTD as part of their content generating staff. Additionally, most of the data acquisition rules (CDRLs, DIDs, TMCRs, specifications, standards, writer handbooks) do not provide the content generator with adequate guidance or information in this area. As a result, contractor MOTD generation is based upon factors such as literal adherence to data acquisition rules, technical accuracy requirements, and acceptance by the reviewing agency. These factors do not sufficiently address User-Data Match principles.

As an example, an initial aspect of content generation which is significantly impacted by User-Data Match considerations is MOTD design. In the current TM system, MOTD design is based upon the general guidelines presented in the MOTD content specifications. However, in most cases, these guidelines are general in nature which gives the content generator the flexibility to present the same information in a number of different manners all of which adhere to the specification. In these cases, the content generator selects the method of presentation he believes most effectively communicates the

information to the user. However, this decision is based on extremely sketchy knowledge of the user's personal characteristics such as years of on-the-job experience, basic intellectual ability (arithmetic reasoning, mechanical comprehension, etc) and previous training. Furthermore, the content generator would probably not know what to do with explicit, detailed human factors data even if it were available to him. As a result, where options exist, the selection of a method of presentation is often based on the preferences or biases of the individual content generator rather than on sound human engineering principles.

User-Data Match research provides the basis for the development of a methodology for designing MOTD based upon considerations such as user personnel characteristics, task analysis, media, environment, and system/equipment characteristics. This methodology, as well as program-unique data necessary to apply it, must be transmitted to the content generator via the data acquisition documents.

TABLE 3-XIII. FACTORS INFLUENCING CONTENT GENERATION

Present Factors	Proposed Additional Factors
• Delivery Schedules	• User Personnel Characteristics
• Literal Adherence to Specifications and Standards	• Media
• Reviewer Acceptance	• Task Analysis
• Personal Preferences and Biases	• Environment
• Technical Accuracy	• System/Equipment Characteristics
• Availability of Engineering/Manufacturing Data Bases	• Training Requirements
• Availability of Hardware	

3.1.3.1 IMPROVED TECHNICAL DOCUMENTATION AND TRAINING PROGRAM

The Army Improved Technical Documentation and Training (ITDT) program is a JPA-type approach to improving technical documentation by preparing all documents to a uniformly low level of difficulty, thus avoiding the problems of achieving a User-Data Match involving more than one type of user.

The Improved Technical Documentation and Training (ITDT) program is an approach to system/equipment support involving complete interface between technical documentation and training. The ITDT program is the result of extensive studies in developing technical data matched to the user in the field with a view toward low-cost system/equipment ownership. The ITDT concept encompasses technical publications and continuous training programs, including both formal and on-the-job training (OJT), developed on a system-by-system or equipment-by-equipment basis.

The ITDT approach is based upon the following: (1) an analysis of a specific system or equipment and related job tasks to be performed, to determine the optimum allocation of procedures for the TM and the training package; (2) development of TM and training package requirements based on this analysis; (3) preparation of the TM and training package to meet the requirements; and (4) distribution and implementation of the TM and training package in the field. The charter which established the ITDT program states that the overall purpose of the program is to improve operational readiness of equipment through more efficient maintenance and training via a close coordination during development of training and technical documentation.

Basically, the ITDT approach is to perform an equipment analysis and functional task analysis, and then a detailed task analysis. This detailed analysis results in a list of tasks which must be covered either in the TM or in training. A judgment decision is then made regarding what goes into the TM, and what is to be covered by training. Following this decision, the TM is prepared using the Job Performance Aid (JPA) format of step-by-step instructions, abundantly illustrated, and written to the abilities of a novice technician. The training package is prepared in such a manner as to cover both school courses and extension courses, with emphasis on extension training. A Training Guide manual is also included in the training package for field supervision use in developing on-the-job training programs to reduce (and, if possible, eliminate) the need for general training.

A complete ITDT package consists of technical documentation and a training package which cover a specific system or equipment. The technical documentation includes all the essential information needed for a novice technician to perform his job tasks. This information is in a simplified, illustrated, step-by-step form of training extension course (TEC) which may be implemented using several media such as paper, audio-visual equipment, and training simulators. TECs are already in use in some Army units.

The ITDT approach deals with the User-Data Match function to a limited extent. Like the approach taken with the JPAs, the ITDT philosophy is to prepare MOTD for use by the "lowest common denominator" of technicians. Following this philosophy eliminates the need for making more than one "match" between the user and the data.

Under the guidelines of the ITDT program, a variety of presentation media, such as audio, audio-visual, microforms, etc., can be proposed for use; however, only variations of the JPA format may be used for conveying the technical data to the user. These formats include the customary short narrative steps keyed to illustration with numbers; flowcharts with branching or non-branching techniques; integrated illustrations; etc.

At the present time, draft specifications for the preparation of TM and training packages following the ITDT philosophy have been developed by Hughes Aircraft Company, Kinton, and RCA. From these specifications, draft MOTD and training packages are presently being developed and are expected to be available in March 1977 for ITDT concept evaluation. Hughes Aircraft Company is presently using Draft MIL-M-632XX (TM) Parts I and II (tentatively to become MIL-M-63039 and MIL-M-63040) developed by Kinton to prepare the TM and training packages for the M551, M551A1, M60, M60A1, M60A2 and M728 tank turrets. The TMs consist of Job Performance Manuals (JPMs) and Job Performance Guides (JPGs) which supplement the JPMs. Extension Training Material (ETM), previously identified as TECs, are to be used to train personnel in the use of JPMs and JPGs for maintenance.

Implementing the ITDT program seems to be a viable method of improving at least part of the User-Data Match, but only extensive field testing and detailed analysis of the results will confirm this concept. Potentially, by matching the data to the lowest technician level, a less-than-optimum may exist with technicians of higher capabilities. Moreover, the applicability of the ITDT technique to all of the existing and foreseen types of technical manuals is an open issue; some types may not be effectively implementable with ITDT. Furthermore, the issue of cost effectiveness must eventually be addressed, i.e., evaluation of the cost increment required to produce ITDT manuals versus the degree of improved usefulness.

Since the ITDT program has not been implemented in the field, no test data is presently available for evaluation. It is recommended that such evaluation not only cover the above matters of user response related to acceptance of the ITDT program and improved maintenance proficiency, but that an attempt also be made to determine the impact on support life cycle costs.

TABLE 3-XIV. KEY ELEMENTS OF THE ITDT PROGRAM

- Experts analyze the equipment
- An optimum procedure is developed for each maintenance operation
- Training tasks are defined
- TM is developed which describes the optimum procedure in a step-by-step fashion using clear text and clear illustrations
- Training media is selected and training package is prepared

3.1.3.2 DAPIL AND GERMAN IPB DOCUMENTATION TECHNIQUES

Two new parts supply documentation systems of interest to NTIPP have been developed recently - the German Air Force Illustrated Parts Breakdown (IPB), and the Digital Assembly Parts Identification Lists (DAPIL) developed by Hughes Aircraft Company for NAVSEA.

The current German Air Force IPB is a far more usable system of equipment parts documentation than is its U.S. counterpart. This IPB is not only a supply catalog, but also functions as a repair and maintenance document.

Although the German Air Force (GAF) Illustrated Parts Breakdown is a direct descendant of the U.S. IPB, there are several major advantages in the GAF version. It is developed so that it forms the basis for the Provisioning Technical Documentation. Basically, in the German system a rough draft IPB with preliminary illustrations is developed initially. This draft is taken to a Provisioning Conference, where it is determined exactly what equipments the IPB is to cover. Following this directive, an IPB is prepared with detailed illustrations which then becomes the basis for developing the Provisioning Technical Documentation. The U.S. version of the IPB and Provisioning Technical Documentation are developed independently. Therefore, the user of the U.S. IPB and Provisioning Technical Documentation frequently finds a great deal of incompatibility between the two. This incompatibility is eliminated in the German system, since the IPB is used as the basis for generating the Provisioning Technical Documentation.

The German Air Force IPB includes extensive indexing and cross-referencing, both of which are much more comprehensive than that found in the U.S. IPB. To aid the user, the German IPB has every equipment part indexed and cross-referenced on one large table by the following headings: main part number; manufacturer's code; national stock number; unit of issue; interchange code; figure and index number; reference designator; work unit code; and units per equipment. The U.S. IPB generally indexes and cross-references only the main part number; source maintenance and recovery code; figure and number index; and reference designator. The U.S. IPB has no "all-inclusive" index or cross-reference table. In addition, there is no reference made to the National Stock Number anywhere in the U.S. IPB. Spare and replacement parts are stored aboard ship by National Stock Number and their provisioning is controlled by the ship's Allowance Parts List (APL) which also identifies all parts by National Stock Number. The APL provides the link between part number and National Stock Number by providing a part number cross-reference. Since the APL is a compilation of all the ship's equipment provisioning lists and each provisioning list is developed independently of its IPB, there is only limited assurance that the part number listings in the IPB and the APL track. The user is likely to encounter difficulties that would not be present if he had a GAF version of the IPB. For example, after identifying the part number, he must spend time to locate the APL and then find the National Stock Number. If no part number is listed in the APL, he has to contact the ship's support facility or part manufacturer to determine correctness of part number and National Stock Number. If the part number is listed in the APL, but the

corresponding National Stock Number has been revised (due to provisioning part number updates or change) the user may get a servo assembly when he orders a steam valve, or vice versa.

Because the German Air Force IPB is arranged in disassembly sequence, is more comprehensive in nature, and uses highly detailed illustrations for parts location, it is also frequently utilized by technicians as a repair and maintenance document. The U.S. IPB cannot easily be used for repair and maintenance, as the illustrations are generally not detailed enough for these purposes.

Due to the relative newness of the German Air Force IPB, no major shortcomings have been identified to date. From a user standpoint, it is by far superior to its U.S. counterpart due to the detailed illustrations and the use of National Stock Numbers for indexing; however, it must be remembered that the scope of its intended use is limited, and therefore it cannot be compared to an "all-inclusive" technical manual.

Digital Assembly Parts Identification Lists (DAPIL) is a newly proposed parts supply documentation system which is more comprehensive than a Maintenance Parts List (MPL) but not as detailed as an Illustrated Parts Breakdown (IPB). DAPIL was recently developed by Hughes Aircraft Company under contract to NAVSEA. The DAPIL locates, describes, and illustrates reparable assemblies and their repair parts for each equipment covered. Part I of a DAPIL manual contains an introduction to the use of the manual. Part II consists of an overview of the equipment and parts assembly list. This list is in Reference Symbol Number order, and includes the Reference Symbol Number; Item Name; Part Number; and Figure Number. The overview and assembly list is followed by an illustration and breakdown, in part number order, of the reparable assemblies in the equipment. The assembly breakdown listing which follows the illustration includes the Reference Symbol Number; Item Name; and Part Number of the assembly and each reference symbol numbered repair part.

Part III of a DAPIL manual is a Part Number Cross-Reference. This reference is in Military Part Number order and includes the Military Part Number; Item Name; Contractor's Part Number; Federal Manufacturer's Code; Reference Symbol Number, Usable On Code; next higher assembly Part Number; and Quantity per article.

As is clearly evident, a DAPIL manual contains an extensive indexing and cross-referencing system. From a user's standpoint this tends to make the manual highly usable.

DAPIL has several major advantages over standard Navy IPB and MPL. DAPIL contains appropriately placed illustrations whereas a standard MPL does not, making the DAPIL manual significantly more "user" oriented. Also, DAPIL has a substantially better indexing and cross-referencing system than either the MPL or the U.S. IPB.

Like the German Air Force IPB the DAPIL is relatively new, and therefore little feedback has been obtained to date regarding any serious shortcomings or disadvantages of its use. However, from a "User-Data Match" point of view, DAPIL appears to be a good compromise between the MPL and the U.S. IPB.

3.1.3.3 USER-DATA MATCH IMPLICATIONS OF VIDEO DISC USAGE

Video disc systems appear to offer great promise for presentation of MOTD to the user, and as a mass storage media for archival and update purposes. However, all video disc systems are still developmental in nature, and only laboratory equipment on which demonstrations using color TV as the high-density program material have been produced.

The video disc system is an emerging recording and playback technique that has the capability of storing vast quantities of data on a disc similar in shape to the audio LP. Various optical, electro-mechanical and magnetic techniques are presently being developed to record and recover data using the video disc. The Poe Engineering Services report[1] provides detailed descriptions of the various video disc techniques, and plans for implementations as well as advantages and disadvantages. Additionally, the NAVPHOTOCEN R&D 76/11 technical report[2] provides an assessment on high-density recording techniques as applied to NTIPP. (Both of these research efforts were sponsored by NTIPP.)

The video disc system as related to MOTD and the User-Data Match could provide an interactive mass storage media used by the following: (1) the content generator in developing MOTD; (2) the MOTD user in the performance of his operating, troubleshooting, and maintenance duties; and (3) MOTD maintenance personnel in the updating of existing MOTD. By adapting various existing and emerging MOTD formats and presentation techniques to video disc technology, the video disc system in conjunction with a properly programmed computer and interactive terminal could form a highly usable active system, as opposed to the current passive systems such as the printed manual and microforms. The level of interaction between the user and the video disc system is limited only by storage capacity, operating environment, cost and man's ingenuity. For MOTD updating, the video disc system outlined above plus the necessary video cameras and camera controls would provide a disc-to-disc transfer capability with the data being revised during the transfer.

The apparent advantages of the video disc system are as follows: very high density information storage capacity; easy random access to stored data; dual sense (audio and visual) presentation; interaction with user; ease of update; potential low video disc costs; and video discs that are easily distributed through the various mailing systems. The storage capacity can be as high as 54,000 individual frames of video, complete TM pictures, individual stills, tabular listings, etc, on one side of a 12-inch disc. Depending upon the particular video disc format, one side of a video disc can replace as

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[1]Poe, Stephen E., "Photographic Video Disc Technology Assessment," Final Report, Poe Engineering Services, October 1976.

[2]Bull, Glen C., "Photographic Video Disc Technology Assessment," Final Report FY76, Naval Photographic Center, Research and Development Department, September 1976.

many as 500 individual microfiche cards, or a 13.5-inch thick technical manual (500 pages printed front and back per inch). Easy random access to stored data can be provided by identifying each stored frame with a code and developing a code index which the operator uses to select the desired data. The capability of recording audio along with video is available in certain video disc formats, in order to enhance the visual presentation. With the MOTD recorded in the proper format, the video disc system could interact with the user. For example, in a troubleshooting situation, the system would present several symptoms, one of which the user selects as closely resembling the observed symptom. The video disc system responds to the selection by presenting the troubleshooting data related to the selected symptom. Updating data in the video disc system is accomplished by simply throwing away the old video disc and installing the new one.

Some of the disadvantages of using the video disc system for MOTD are single frame-viewing, MOTD availability sometimes limited, and user environmental condition inadequacies. The recording format and techniques provide for viewing only one frame at a time. The same frame may be repeated at the rate of 30 frames per second for stop motion, or advance one frame at a time at the 30-frame/second rate for motion pictures. There is no way to view more than one page frame at the same time. The video disc system, like all automated data systems is susceptible to internal failures and power failures, at which times the MOTD becomes unavailable to the user. The shipboard environmental conditions probably present one of the biggest user problems for the video disc system. Transporting and operating the system in confined spaces along with the necessary tools and test equipment may become an impractical if not impossible task.

Additional problems associated with video disc systems include standardization of recording formats and techniques, and the replication processes. However, as the video disc industry develops and expands, and as the technology becomes firm, industry standards will be established and these problems will be solved. It was estimated in the Poe Engineering Services report that "...development and successful marketing of a low-cost optical video disc machine having full recording, as well as playback capabilities is only a matter of time. Best guess on time: within 5 years."

3.1.3.3 USER-DATA MATCH IMPLICATIONS OF VIDEO DISC USAGE (Continued)

TABLE XV. ADVANTAGES AND DISADVANTAGES OF VIDEO DISC RELATIVE TO MOTD

Advantages Relative to MOTD

- Very high density information storage capacity (54,000 frames per one side of 12-inch disc)
- Easy random access to stored data (2 to 5 seconds)
- Dual sense (audio and visual) presentation available
- Interactive with user (keyboard/CRT)
- Easily updated by disc replacement
- Potential low video disc cost (50 cents to 10 dollars)
- Video discs easily distributed to user through mail systems

Disadvantages Relative to MOTD

- Single frame viewing
- Data availability limited by video disc equipment and power failures
- User environmental conditions (ie, servicing equipment in confined spaces)

SUBSECTION 3.2
RESEARCH ISSUE 2: DATA ACQUISITION

3.2.0 DEFINITION AND OBJECTIVES OF DATA ACQUISITION

Data acquisition is the process of procuring technical manuals (TMs). It involves the formulation and implementation of policies and procedures for acquiring TMs. Its objective is to cause the delivery of accurate and quality TM products to the TM user.

The acquisition of technical literature such as TMs by components of the Department of Defense is handled by Acquisition or Technical Manual Managers within a service branch (Army, Navy, Air Force). The tools used by these managers to acquire data and to control the processes are military specifications, standards, preparers' handbooks and guides, internal directives and guidance documents. The processes and procedures developed for TM acquisition within a military service branch are usually the result of interpreting gross requirements of higher-level directives. Each service branch then formulates its own unique policies and procedures for TM acquisition, and puts them into practice. Policies and procedures formulated by the military services for TM acquisition usually address elements of TM acquisition such as TM requirements determination, planning, contractor procedures and interfaces with the acquiring agencies, TM reviews, validation, verification, military specifications with which TMs are to be designed, and other processes during the TM life cycle.

The objective of data acquisition is to purchase, and cause to be built, TM products which are geared to an intended user population. The TM acquiring activity must translate to a content generator (contractor or in-house activity), through policies, procedures and specifications, the requirements of a variety of factors which influence the design and development of the TM product. The most significant impact on the design and development of the TM product is the user and his requirements. The translation of these requirements to the content generator is accomplished by invoking the proper TM specifications and other TM requirements in the contract. This assures the design of a TM which most nearly meets the user needs.

Though TM specifications are the basic tools with which TMs are defined and developed, TM acquisition policies and procedures must treat all facets of the TM life cycle. Effective reviews, validation and verification procedures are also essential if a quality TM product is to evolve. TM updates and changes, and timely distribution to users, are other significant processes during the TM life cycle.

The constant development of new TM design and presentation techniques, and evolving equipment and user TM requirements, necessitates a dynamic data acquisition function. TM acquisition policies, procedures, and TM specifications must constantly change to reflect these needs. How responsive the data acquisition function is to these needs, and its control of the critical processes in the TM life cycle, is a significant factor in the quality and usefulness of TM products being supplied to users.

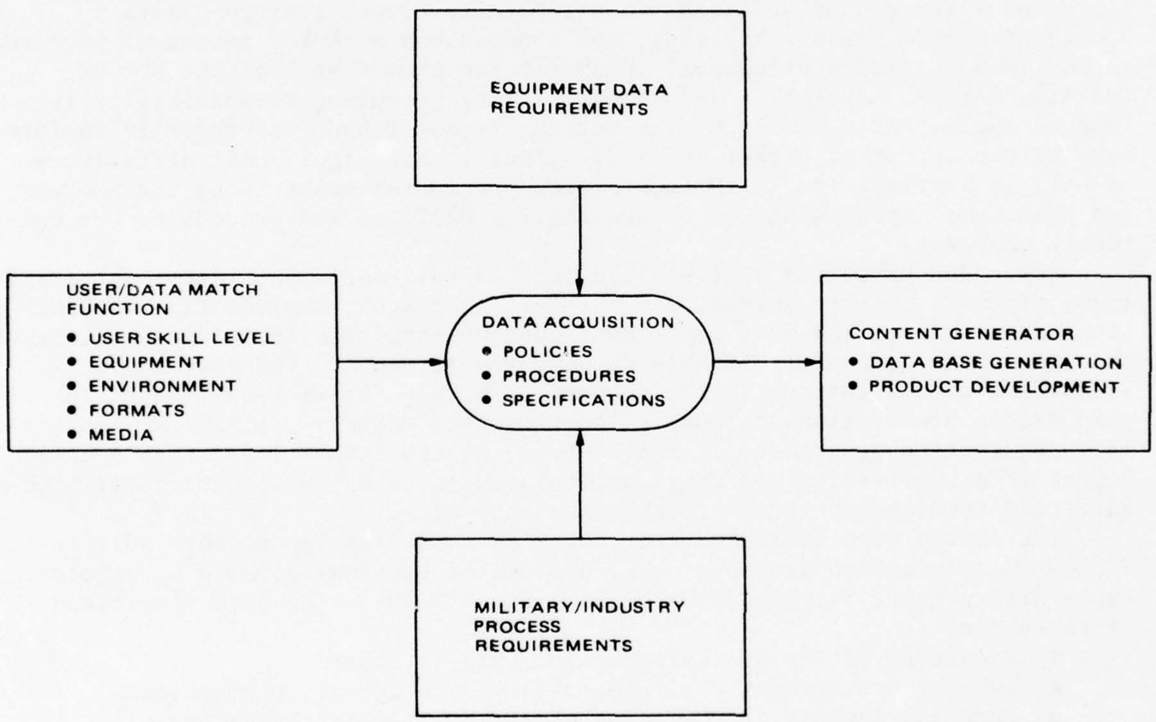

Figure 3-2. Data Acquisition Interfaces. Several external and internal influences must be accommodated in defining requirements for data acquisition policies, procedures, and specifications.

3.2.1.1 SURVEY OF NAVY ACQUISITION POLICIES AND PROCEDURES

NAVAIR, NAVSEA, and NAVELEX SYSCOMs are the prime procurers of TMs within the Navy. Policies and procedures for performing their respective TM acquisition functions are formulated and implemented by each. While similarities exist in the major functional processes of TM acquisition among the SYSCOMs, the details of practical application vary widely. There is a common ground among the SYSCOMs upon which standardization of these policies, procedures, and practices could evolve.

To establish an effective baseline for subsequent planning and development efforts, a comprehensive survey of existing Navy policies and procedures on TM acquisition was conducted during the reporting period. The survey consisted of a review and analysis of current directives, liaison visits to pertinent SYSCOM field activities, and discussions with key personnel involved in the TM acquisition processes. Emphasis was principally on the SYSCOM (NAVAIR, NAVSEA, NAVELEX) level, since primary procuring responsibility is located there. As a result of the survey, it was found that there is conformance to the intent of higher level directives, that significant differences as well as similarities in TM acquisition procedures exist among the SYSCOMs, and that some improvements to TM acquisition policies and procedures are currently underway.

While DoD Directive 4151.9, Technical Manual Management, dated January 7, 1975, provides uniform guidance to the three Services, implementing instructions down through the Navy Department command structure introduces policies and procedures uniquely relatable to Navy requirements. For example, SECNAVINST 5000.1 introduces the concept of Navy-peculiar requirements in ship system acquisitions as opposed to aircraft, vehicles, missiles, and similar acquisition programs. It is, however, at the SYSCOM level that a noted degree of nonuniformity sets in, particularly in relation to procedural mechanics and terminology in the TM acquisition process.

The survey also indicated that numerous variables impact the individual SYSCOM TM acquisition processes and, because of internal command structures, cause divergencies in procedures between the SYSCOMs. The more significant of these are:

- Magnitude of the system/equipment being procured
- Type of procurement - off-the-shelf, development, production
- Type and numbers of TMs being procured - new or change/revision
- Number and type of personnel involved in the acquisition
- Degree of personnel involvement - full time, or as required
- Types and content of contractual documents being used - CDRL, DID, TMCR, SOW
- Capabilities, locations, degrees of confidence in the preparing activities/contractors

These variables directly impact the "who, what, where, when and how" of accomplishing the major functional processes required in TM acquisition. For example, in the procurement of development type hardware, it may not be possible to firmly determine TM requirements until design freeze, whereas in a production procurement it is possible to make this determination immediately. The net effect of these variables is to discourage a SYSCOM from standardizing its approach to similar TM acquisitions.

The survey did show that there is similarity between the SYSCOMs in TM acquisition at the major function level with some similarity at the subfunction level. These individual major functions (which each SYSCOM performs in any TM acquisition to varying degrees) are shown in Figure 3-3. The individual SYSCOM policy and procedure instructions[1] provide the requirements and guidance for the performance of these major functions, and in some instances identify the responsible activity. There are, of course, differences between what is required by these instructions and what is actually happening in the real world. However, in spite of differences in practice, the SYSCOM policy and procedure instructions provide a basis for expansion of inter-SYSCOM standardization, and/or for future development of a single Navy-wide TM acquisition system.

One significant discovery during this survey was the lack of awareness in branches of the Navy currently involved in related matters. In a recent letter[2] to the CNM from COMNAVAIRSYSCOM, many of the current problems with TMs are recited. The letter recommends various NAVAIR proposed solutions to the problems. It is interesting to note that a significant CNO initiated program (NTIPP) is working in many of the areas proposed by the letter, but is not recognized as a potential source for solving some of the problems.

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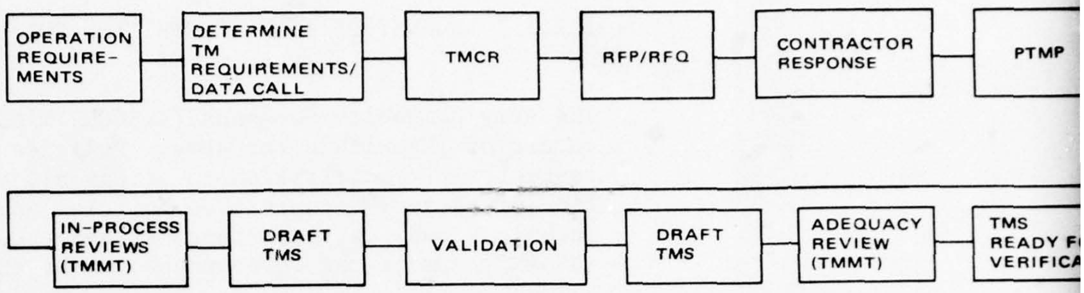
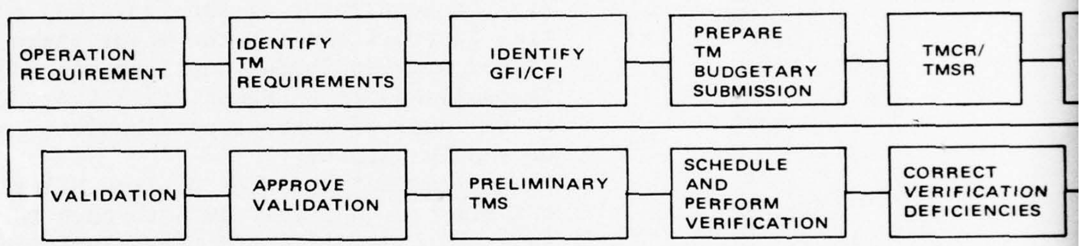
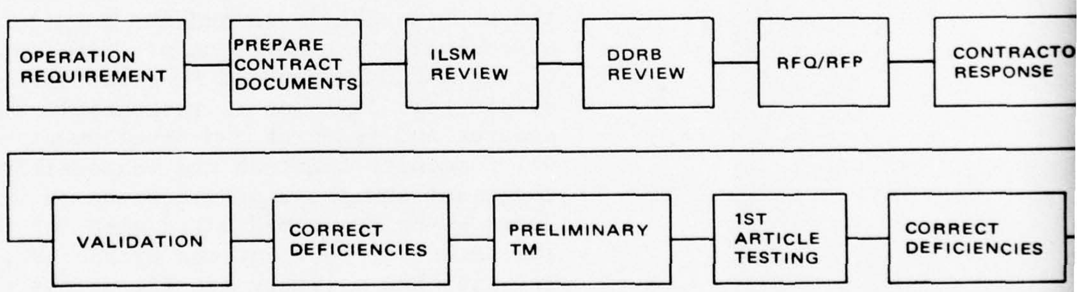
[1]NAVSEAINST 5600.7, "NAVSEASYSCOM Technical Manual Acquisition; Policies and Responsibilities For," 21 July 1976
NAVSEAINST 5600.8, "NAVSEASYSCOM Technical Manual Maintenance; Policies, Procedures and Responsibilities," 21 July 1976
NAVAIRINST 5600.5A, "System for Preparation and Promulgation of Interim Changes to NATOPS Flight Manuals," 9 July 1976
NAVAIRINST 5600.7A, "Aeronautical Technical Manual Requirement Code; Instructions Concerning Determination, Assignment and Approval Of," 6 February 1976
NAVAIRINST 5600.9A, "Policies and Responsibilities for Management and Coordination of Technical Manual In-Process Reviews, Validation and Verification," 19 October 1973
NAVAIRINST 5600.16A, "Technical Manual Program, Procedures and Responsibilities for the Planned Maintenance System Technical Documentation," 29 August 1974
NAVAIRINST 5600.19A, "Policy, Procedures and Responsibilities for Technical Manual Rapid Action Change Program," 5 January 1976
NAVAIRINST 5600.20A, "Policies and Responsibilities for the Naval Air Systems Command Technical Manual Program," no date
NAVAIRINST 4000.9A, "Management of Technical Data," 30 July 1971
NAVELEXINST 5600.7, "Acquisition and Quality Assurance of Technical Manuals for New Equipment/Systems; Requirements For," 18 August 1975

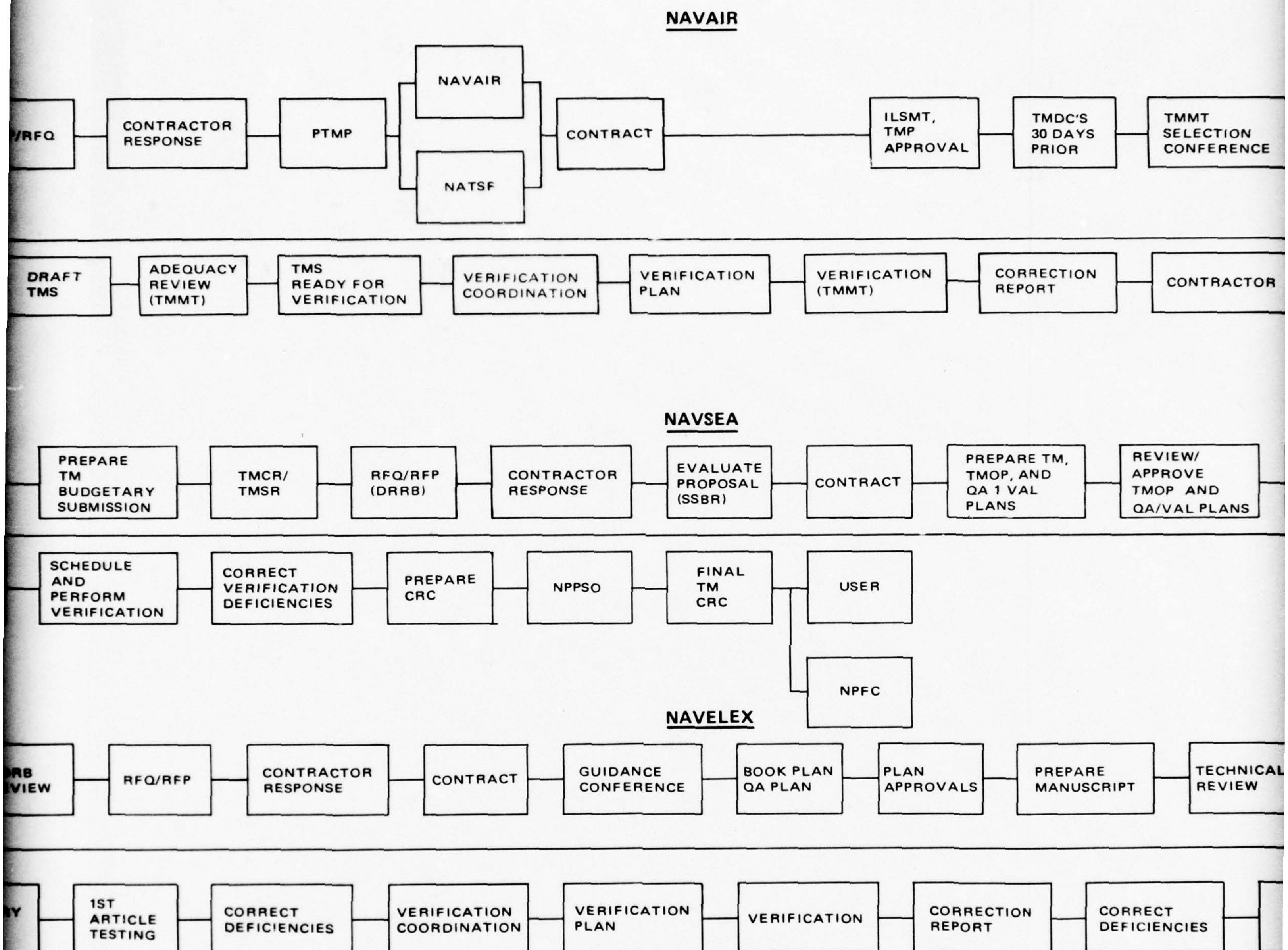
[2]COMNAVAIRSYSCOM ltr dated 12 Nov 1976, to CNM (MAT04), "Standardization of the Navy Technical Documentation System; Recommendations concerning"







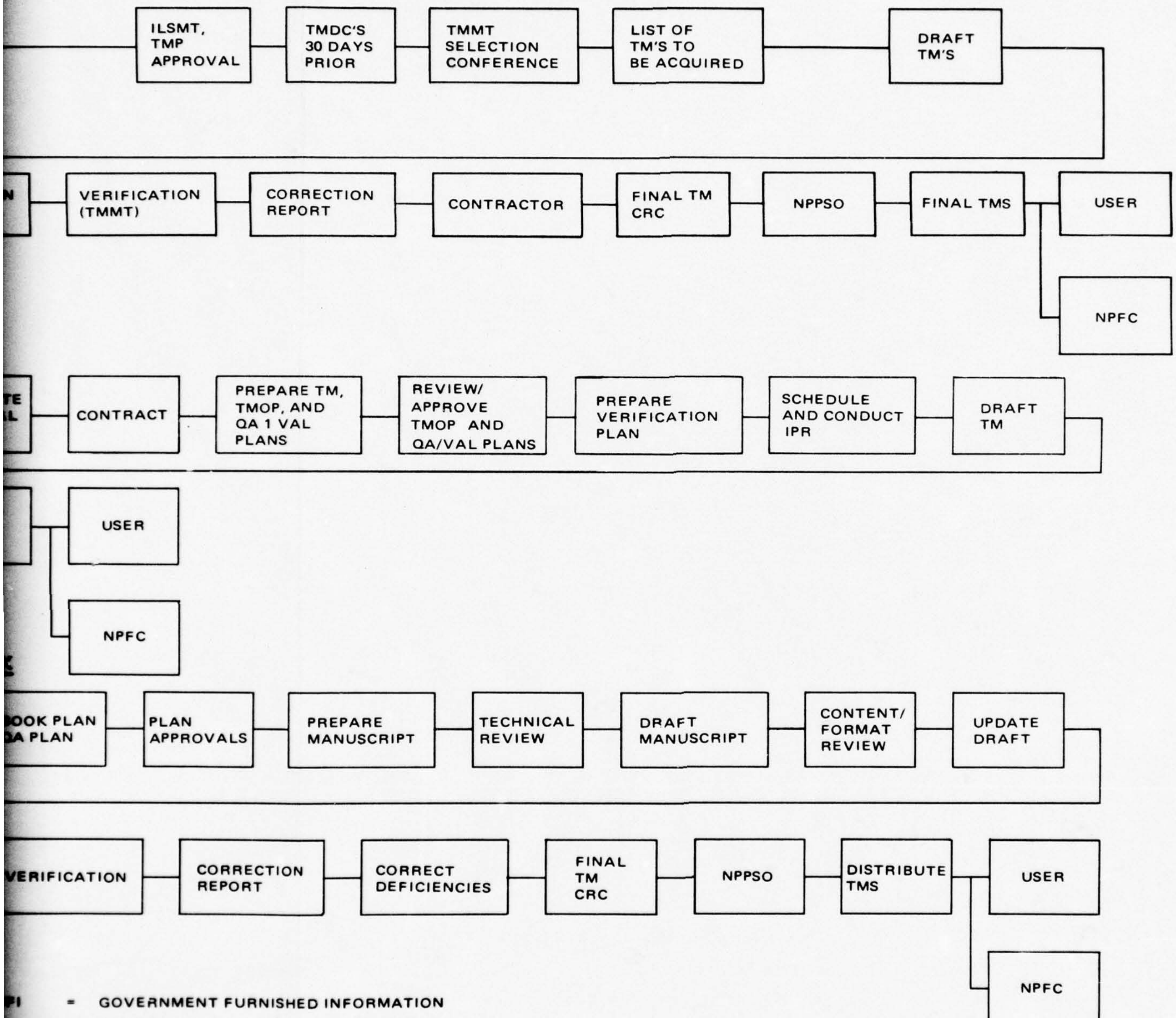
TMCR = TECHNICAL MANUA
RFP = REQUEST FOR PROF
RFQ = REQUEST FOR QUOT
PTMP = PRELIMINARY TECH
ILSMT = INTEGRATED LOGIS
TMDC = TECHNICAL MANUA
TMMT = TECHNICAL MANUA
CRC = CAMERA READY CO



LEGEND

TMCR = TECHNICAL MANUAL CONTRACT REQUIREMENT
RFP = REQUEST FOR PROPOSAL
RFQ = REQUEST FOR QUOTE
PTMP = PRELIMINARY TECHNICAL MANUAL PLAN
ILSMT = INTEGRATED LOGISTIC SUPPORT MANAGEMENT TEAM
TMDC = TECHNICAL MANUAL DATA CARD
TMMT = TECHNICAL MANUAL MANAGEMENT TEAM
CRC = CAMERA READY COPY
GFI = GOVERNMENT FURNISHED INFORMATION
CFI = CONTRACTOR FURNISHED INFORMATION
TMSR = TECHNICAL MANUAL SEATASK REQUIREMENT
DRRB = DATA REQUIREMENT REVIEW BOARD
SSBR = SOURCE SELECTION BOARD REVIEW
TMOP = TECHNICAL MANUAL OPERATING PLAN
NPPSO = NAVY PUBLICATIONS AND PRINTING SERVICES OFFICE
ILSM = INTEGRATED LOGISTIC SUPPORT MANAGER
NPFC = NAVAL PUBLICATIONS AND FORMS CENTER

Figure 3-3. General Navy TM
functional processes between
the "who, what, where, and h



FI = GOVERNMENT FURNISHED INFORMATION
FI = CONTRACTOR FURNISHED INFORMATION
MSR = TECHNICAL MANUAL SEATASK REQUIREMENT
RRB = DATA REQUIREMENT REVIEW BOARD
SR = SOURCE SELECTION BOARD REVIEW
OP = TECHNICAL MANUAL OPERATING PLAN
PPSO = NAVY PUBLICATIONS AND PRINTING SERVICES OFFICE
SM = INTEGRATED LOGISTIC SUPPORT MANAGER
PFC = NAVAL PUBLICATIONS AND FORMS CENTER

Figure 3-3. General Navy TM Acquisition Processes. Although the major functional processes between SYSCOMS are basically the same, internally, the "who, what, where, and how" vary widely in accomplishment.

3.2.1.2 SURVEY OF ARMY ACQUISITION POLICIES AND PROCEDURES

The Army Commodity Commands (AVSCOM, MICOM, ECOM, ARMCOM, etc) are the prime procurers of TMs within the Army. Policies and procedures for performing their respective TM acquisition functions are applicable to all commands. The coordination of these TM acquisition policies and procedures is performed by a central Technical Publications Branch within the U. S. Army Maintenance Management Center (USAMMC) arm of the Development, Acquisition and Readiness Command (DARCOM).

Department of the Army Equipment Publications - As defined in AR 310-3,[1] Paragraph 8-1a, Army publications are those which deal with the installation, operation, maintenance, and repair parts support of Army materiel. Technical manuals, technical bulletins, lubrication orders, and modification work orders are the Department of the Army (DA) publications used to provide these essential instructions for the major items of equipment. A listing of all published Army equipment publications and changes, prepared by Army components, is published in DA Pamphlet[2] 310-4, "Military Publications." This pamphlet is an index of current publications pertaining to equipment or of a technical or supply nature.

Organization - The US Army Maintenance Management Center (USAMMC) was established on 1 July 1973 through the merger of five agencies which were separate Class II Activities (logistic support vs Class I troop commands) of the US Army Materiel Command (USAMC) reporting to the Director of Maintenance. All of these are now merged at Lexington, Kentucky, comprising one Class II Activity of the US Army Materiel Development, Acquisition, and Readiness Command (DARCOM) which was formerly USAMC. The USAMMC is the DARCOM link between the user in the field and the supplier at the wholesale level. The Maintenance Evaluation Division of USAMMC has the responsibility for program control of the DARCOM Equipment Publications Program. A Technical Publications Branch within this division is responsible for coordinating overall policies and procedures and research and development efforts for Army publications. Individual Commodity Commands are responsible for the acquisition of their individual cognizant equipment publications in accordance with the policies and procedures which are coordinated with the USAMMC Technical Publications Branch. The Technical Publications Branch is also responsible for coordinating and revising the military specifications which the Commodity Commands use to procure their equipment publications.

Army Policies and Procedures - ARs[1,3,4] 310-1, -2, and -3 assign responsibilities and set forth basic policies for program management and preparation of Army equipment publications. AR 310-3 assigns responsibilities to HQ DA Deputy Chief of Staff for Logistics (DCSLOG) for staff supervision over the

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[1] AR 310-3, "Preparation, Coordination and Approval of Department of the Army Publications," Mar 1976

[2] DA PAM 310-4, "Military Publications," Nov 1974

[3] AR 310-1, "Publication, Blank Forms, and Printing Management," Mar 1974

[4] AR 310-2, "Identification and Distribution of DA Publications and Issue of Agency and Command Administrative Publications," Sept 1976

Army equipment publications program; to CG, DARCOM for overall program direction; and to Commodity Commands for the preparation of equipment publication for each major item of equipment which requires repair parts and maintenance support. These responsibilities are restated in AR[5] 750-1 which assigns responsibilities to HQ DA (DCSLOG) for Army general staff responsibility over the Army equipment publications program; to CG, DARCOM, for developing and managing the equipment publications program and to Commodity Commands for preparing, acquiring, and maintaining current equipment technical publications which cover technical operation, maintenance, and repair parts requirements for program management, the use of manufacturers' publications, coordination and review requirements, and the format and content of technical publications.

Basic management policies in AR 310-3 for the equipment publications program requires review and approval of schedules; consolidation, maintenance, and publication of the program schedule and accomplishments; collection, consolidation, and maintenance of cost data on the preparation or procurement of equipment publications; compliance with regulatory documents in the preparation or procurement of equipment publications, establishment and maintenance of a user information feedback system; maximum utilization of manufacturers' publications; and maintaining the library of equipment publications current.

Policies on the format and content of equipment publications in AR 310-3 and AR 750-1 are general, with detailed requirements suitable for in-house preparation or procurement of manuscripts contained in military specifications. Army specifications for the procurement of equipment publications consist of both fully coordinated (DoD) and limited coordinated (Army) documents. The documents are prepared, revised and amended in accordance with policies and procedures of the Defense Standardization Program (DoD 4120.3-M), and fall within the Technical Manual Specifications and Standards (TMSS) standardization area. There are presently seven DoD and 34 DA specifications (see topic 3.2.1.5) used to procure Army equipment manuals. Pamphlets of the 310 series are also used to provide guidance on preparation of equipment publications procurement packages, illustrations, and tabular presentations.

AR 310-2 provides Army policy on the type of publication media to be used for different categories of information, the proper numbering of these publications, and distribution. Only the policies on numbering are applied. Other Army regulations of the 310 series implement these policies and establish centralized control over the assignment of these numbers to insure proper usage and preclude duplication.

AR 310-1 covers Army policy on the printing of DA publications. All printing of these publications is controlled and must be authorized by The Adjutant General (Army Publications Division). Printing is actually accomplished by the Government Printing Office (GPO) or contractors. Deferred Maintenance Work Requests (DMWRs) are Army publications printed by Army field printing plants located at the Commodity Commands. AR 310-1 contains policy on the establishment and operation of these field printing activities in the

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[5] AR 750-1, "Army Materiel Maintenance Concepts and Policies," May 1972

3.2.1.2 SURVEY OF ARMY ACQUISITION POLICIES AND PROCEDURES (Continued)

Army. Overall management and control of Army field printing plant activities is a responsibility of the HQ DARCOM, Administrative Management Office.

Maintaining the Army library of equipment publications current by the publication of revisions, changes, and the rescission of obsolete publications is a responsibility of the Commodity Commands. The criteria for revision of an equipment publication are contained in AR 310-3 which sets forth general revision criteria for all bound and loose leaf Army publications, and also specific revision criteria for equipment publications. Technical and catalog data changes which necessitate the revision or change of equipment publications originate from such sources as:

(a) User information feedback system
(b) Army Master Data File
(c) Equipment Improvement Reports
(d) Design changes
(e) Modification of equipment in field Army use
(f) Post publication reviews
(g) Essentiality review of the library

Based on technical and catalog data changes received from the above sources, Commodity Commands initiate action to prepare changes to their cognizant equipment publications. Prior approval of HQ DARCOM to prepare these changes is not required.

General Acquisition Procedures - In accordance with the requirements of established Army procedures, each Commodity Command within the Army follows the same general procedures in their acquisition of equipment publications. A composite flow of this process is shown in Figure 3-4. There are slight variations in this process within each Commodity Command, occasioned by organizational structure, and/or size and importance of the procurement. Some functions may be combined or deleted and the sequence of the process may be changed from one acquisition to the next.

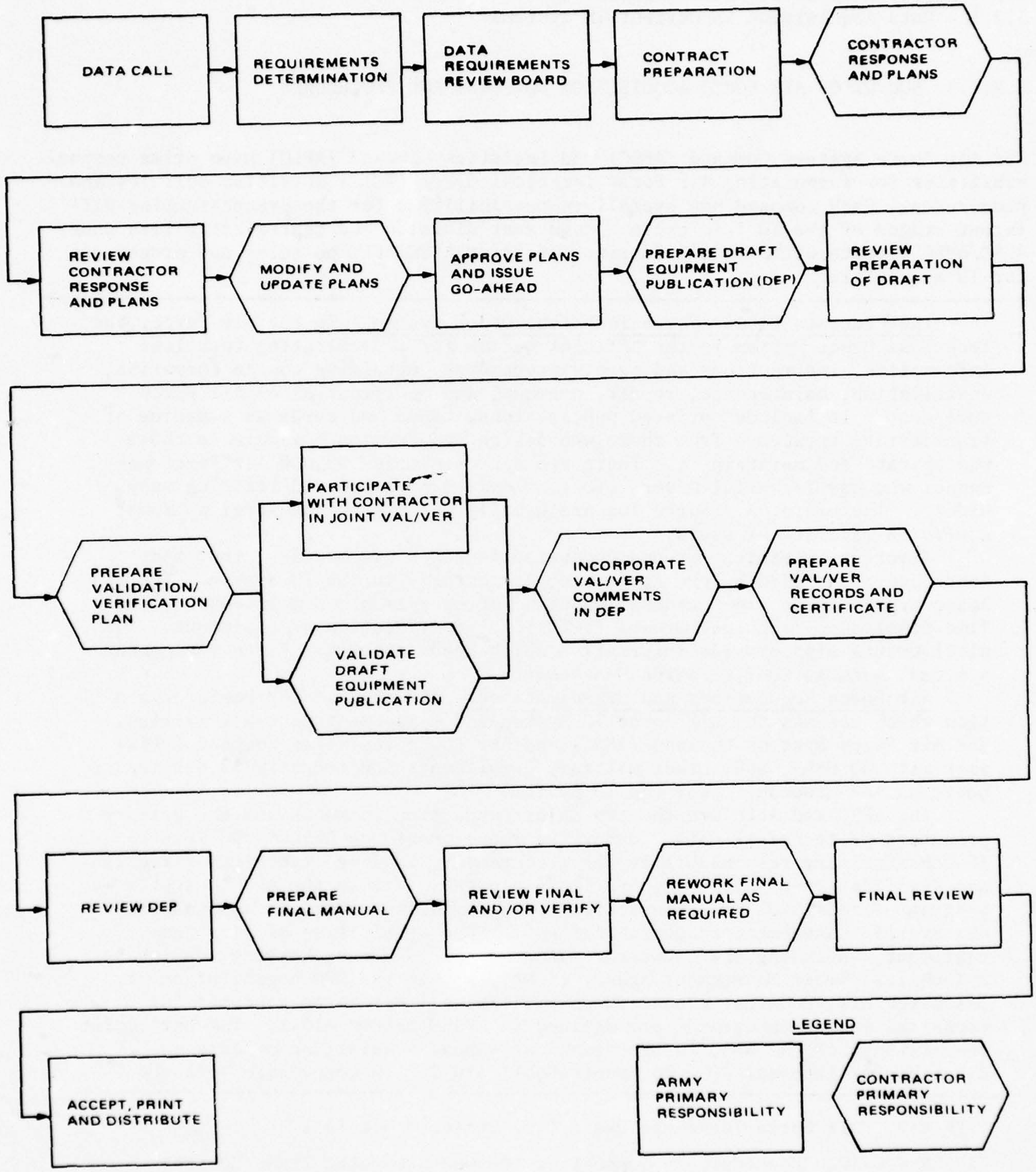

Figure 3-4. Typical Equipment Publication Acquisition Process in the Army. While the Equipment Publication acquisition process may vary slightly between Army Commodity Commands, the process illustrated is representative of the overall process.

3.2.1.3 SURVEY OF AIR FORCE ACQUISITION POLICIES AND PROCEDURES

The Air Force Systems Command (AFSC) and Logistics Command (AFLC) have prime responsibilities for formulating Air Force Technical Order (TO) acquisition policies and procedures. Each command has overall responsibilities for the process during different stages of the TO life cycle. Cognizant division and center activities under AFSC/AFLC operate within the guidelines of joint AFSC/AFLC policies and procedures for TO acquisition.

Introduction to Air Force Technical Order System - In the Air Force, the Technical Order System is the official medium for disseminating technical information, instructions and safety procedures pertaining to the operation, installation, maintenance, repair, overhaul and modification of Air Force equipment. It includes printed publications, tapes and cards as a medium of transferring knowledge from those who design and develop hardware to those who operate and maintain it. There are approximately 300,000 Air Force personnel who use Technical Orders (TOs). Their experience and training vary widely. Therefore, Air Force TOs are usually written to the level appropriate for a majority of users.

Aircraft, missiles, ground communications and electronics, test and other equipment used by the Air Force, are covered in the TO System. The two basic types of TOs are technical manuals for operation and maintenance, and Time Compliance Technical Orders (TCTOs) for modification of equipment. Technical Orders also provide information which feeds other Air Force management systems, such as Configuration Management.

Air Force Regulations and Organizations - AFR[1] 8-2 is the basic regulation which defines the Air Force TO System and management responsibilities. The Air Force Systems Command (AFSC) and Air Force Logistics Command (AFLC) work with HQ USAF, DoD, other military departments and industry in developing policies and procedures for the TO System.

The AFSC and AFLC are the two major supporting commands and the primary procurers of technical data. Under the requirements of AFSCR[2] 400-10, the AFSC has primary responsibility for procurement, funding, technical direction and verification of Air Force systems/equipment. Within the AFSC a system program office (SPO) or project office/program office (PO), as applicable, has overall management responsibilities for the acquisition of a system/equipment, including the technical manuals. The SPO may, however, designate a Technical Order Management Agency (TOMA), within the SPO organization, to discharge his technical manual responsibilities. Air Force concepts for technical manual management are defined in AFSCM/AFLCM[3] 310-1. The particular requirements of the AFSC in the technical manual acquisition process are described by internal AFSC document AFSCM[4] 310-2. In accordance with the

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[1]AFR 8-2, "Air Force Technical Order (TO) System," Nov 1971

[2]AFSCR 400-10, "Procedure in Support of the DoD Stragetic Trade Control Program," Feb 1975

[3]AFSCM/AFLCM 310-1, Vol. II, "Management of Contractor Data," June 1969

[4]AFSCM 310-2, "Technical Publications Acquisition Manual," May 1971

AF800 series regulations (Acquisition Management), the management of the technical manual acquisition process becomes the responsibility of the AFLC at the completion of the production and deployment phases of a system/equipment.

Air Force Acquisition Process - There are approximately 90,000 manuals in the Air Force TO System. Technical Orders are prepared in accordance with Air Force-peculiar, limited coordination and DoD military specifications. There are potentially 3,000 distribution codes to which Air Force TOs may be shipped. The overall process for the Air Force TO system is shown in Figure 3-5. A brief description of some features of this system follows.

As in other military services, the initial determination of the need for Air Force TOs is based on the maintenance concept for the hardware. For weapon systems or for major subsystems or equipment, there is usually a Technical Order Planning Conference. This is a meeting at which the AFSC, AFLC, the major using commands for the systems, and the principal contractor or contractors concerned, based upon the maintenance concept, determine in more specific detail the exact requirements for specific TOs to support the hardware. The requirements become a part of the contract for the end item of equipment. The same funds used to buy the hardware are used to buy the technical orders for its support.

After initial determination of TO requirements is made on known equipment, the prime contractors are also required to submit notices covering Contractor Furnished Aeronautical Equipment (CFAE) or Contractor Furnished Equipment (CFE) as they initiate procurements for such items. They also recommend whether or not a TO is required to support the item. An approved TO requirement becomes a part of the contract.

All Air Force TOs are subject to some form of review. The extent to which they are reviewed depends upon the type of publication. In general, TOs required for flight operations, launching or similar ground operation and for organizational maintenance are verified prior to acceptance by the Air Force. The magnitude of this job precludes anything approaching 100 percent review. Consequently, in actual practice the verification continues for a period of years after the system or equipment becomes operational.

Technical Orders are printed either commercially or through an Air Logistics Center (ALC) printing plant. The TO is then distributed to the activities who must make known their requirements. The central TO distribution organization is located at the Oklahoma City Air Logistics Center (OCALC). When requirements are initially established for a TO, the cognizant Air Logistics Center obtains a TO number from OCALC. The OCALC lists all Air Force TOs in Publication Requirement Tables, from which Air Force activities select their TOs.

The requirements established by the using activities are machine processed at OCALC so that at the time the reproducible material for the TO is ready to be printed, the quantities required for initial distribution are known. Address labels are also a machine product. The TOs are distributed directly from the printer to the using organization. If using activities have additional requirements for TOs beyond those established in Publication

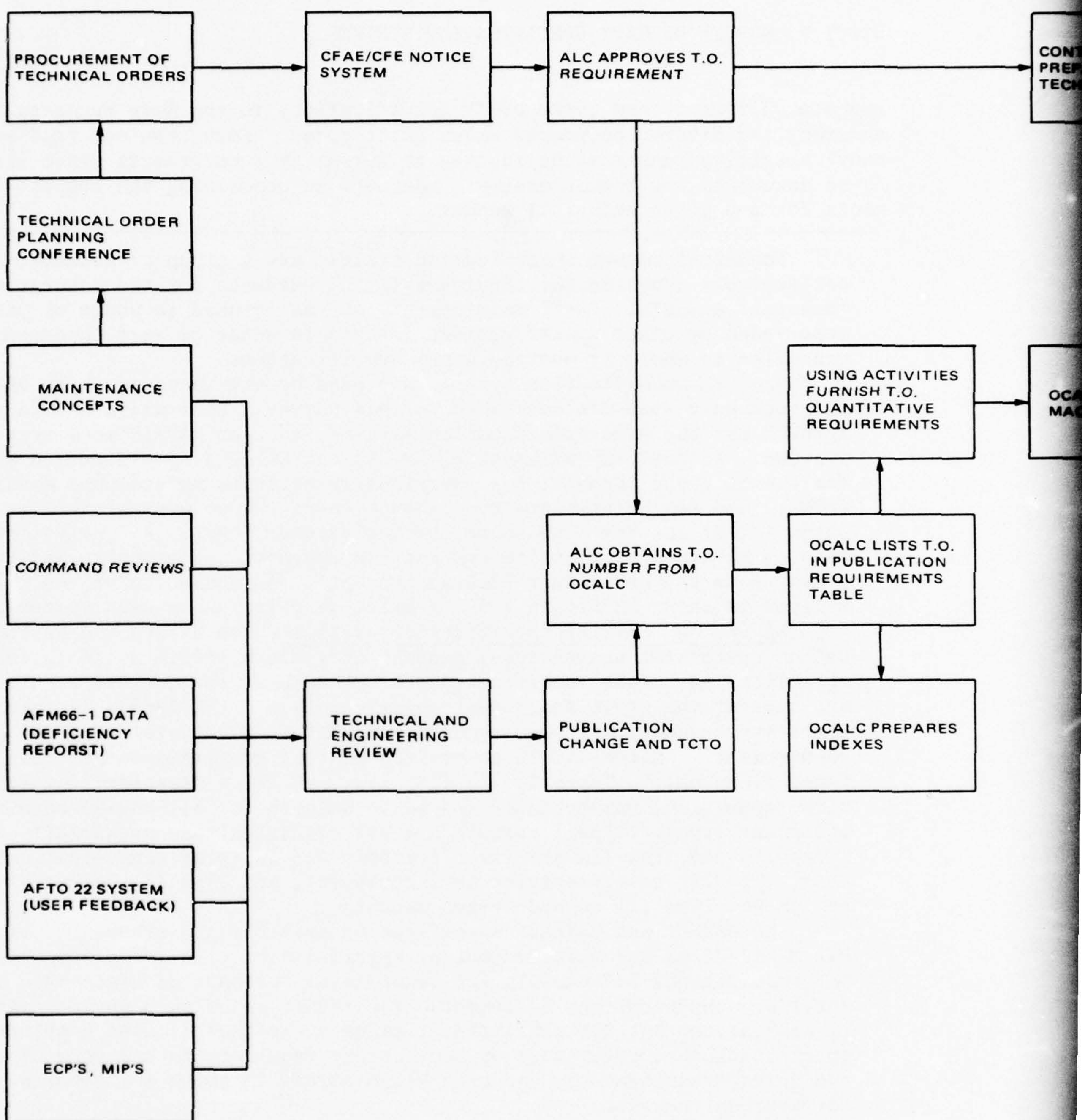
3.2.1.3 SURVEY OF AIR FORCE ACQUISITION POLICIES AND PROCEDURES (Continued)

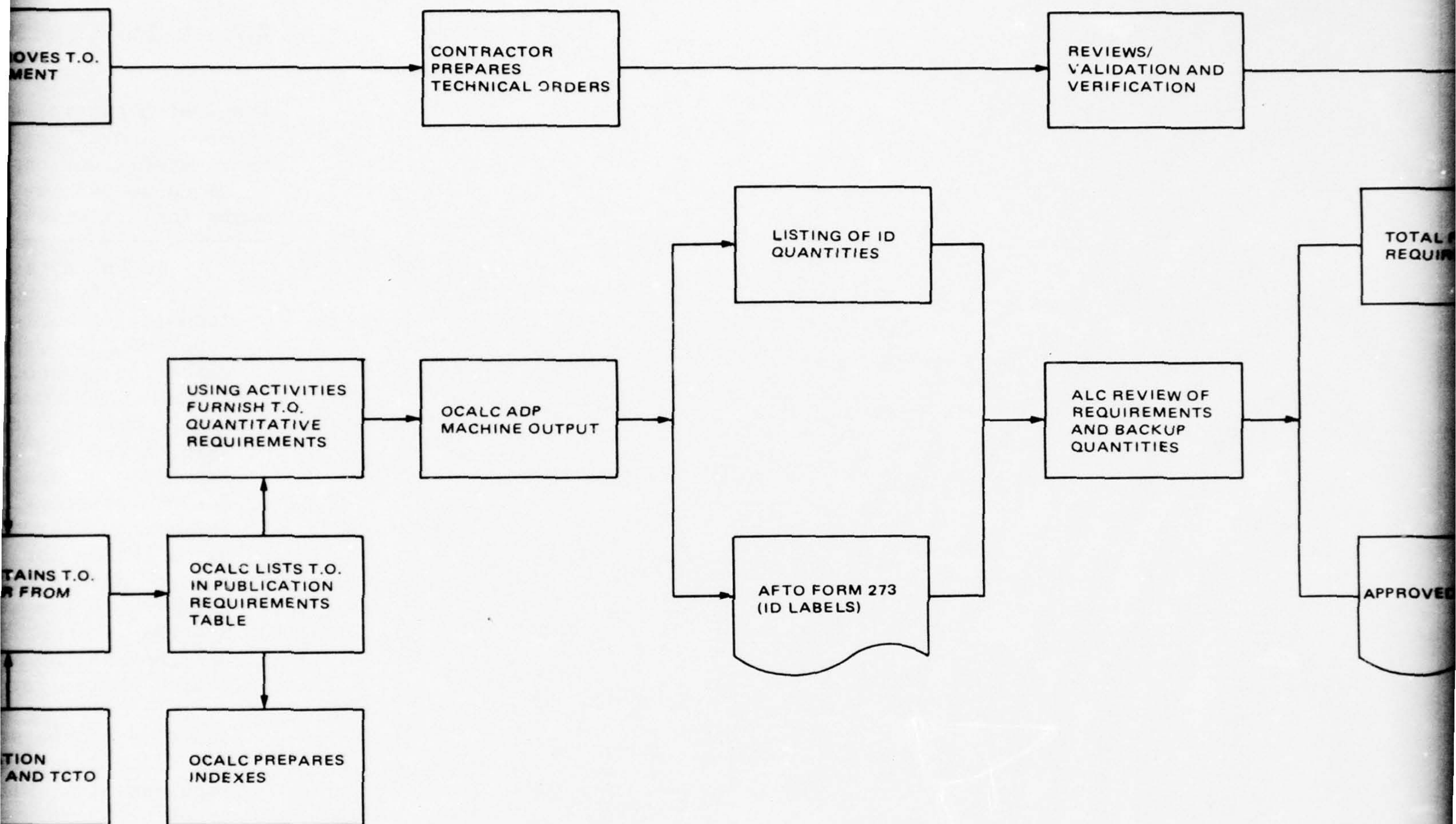
Requirement Tables, they obtain them by requisition. If the additional TO is a one-time requirement, the requisition will be submitted to the prime ALC. If the using activity wants to be put on distribution for a TO, including subsequent revisions, the requisition is submitted to OCALC. The prime ALC maintains a backup stock of all their cognizant TOs. Reprints are obtained as required to maintain the backup stock.

After the TO is in the field, there are several ways in which they are changed or completely revised. For some TOs, particularly the aircraft flight manuals, there are periodic command reviews. These reviews usually result in changes to the TO, based on operational experience of the using activity.

Under the reporting procedures of AFM 66-1,[1] deficiencies may be revealed which require correction through the medium of TO changes. These deficiencies are submitted on AFTO Form 22. Numerous other changes to TOs are the result of Engineering Change Proposals (ECP) and Material Improvement Projects (MIP).

[1] AFM 66-1, "Maintenance Management," Nov 1975


PROCUREMENT OF TECHNICAL ORDERS
CFAE/CFE NOTICE SYSTEM
ALC APPROVES T.O. REQUIREMENT
CONT PREF TECH
TECHNICAL ORDER PLANNING CONFERENCE
MAINTENANCE CONCEPTS
USING ACTIVITIES FURNISH T.O. QUANTITATIVE REQUIREMENTS
OCA MAC
COMMAND REVIEWS
ALC OBTAINS T.O. NUMBER FROM OCALC
OCALC LISTS T.O. IN PUBLICATION REQUIREMENTS TABLE
AFM66-1 DATA (DEFICIENCY REPORST)
TECHNICAL AND ENGINEERING REVIEW
PUBLICATION CHANGE AND TCTO
OCALC PREPARES INDEXES
AFTO 22 SYSTEM (USER FEEDBACK)
ECP'S, MIP'S



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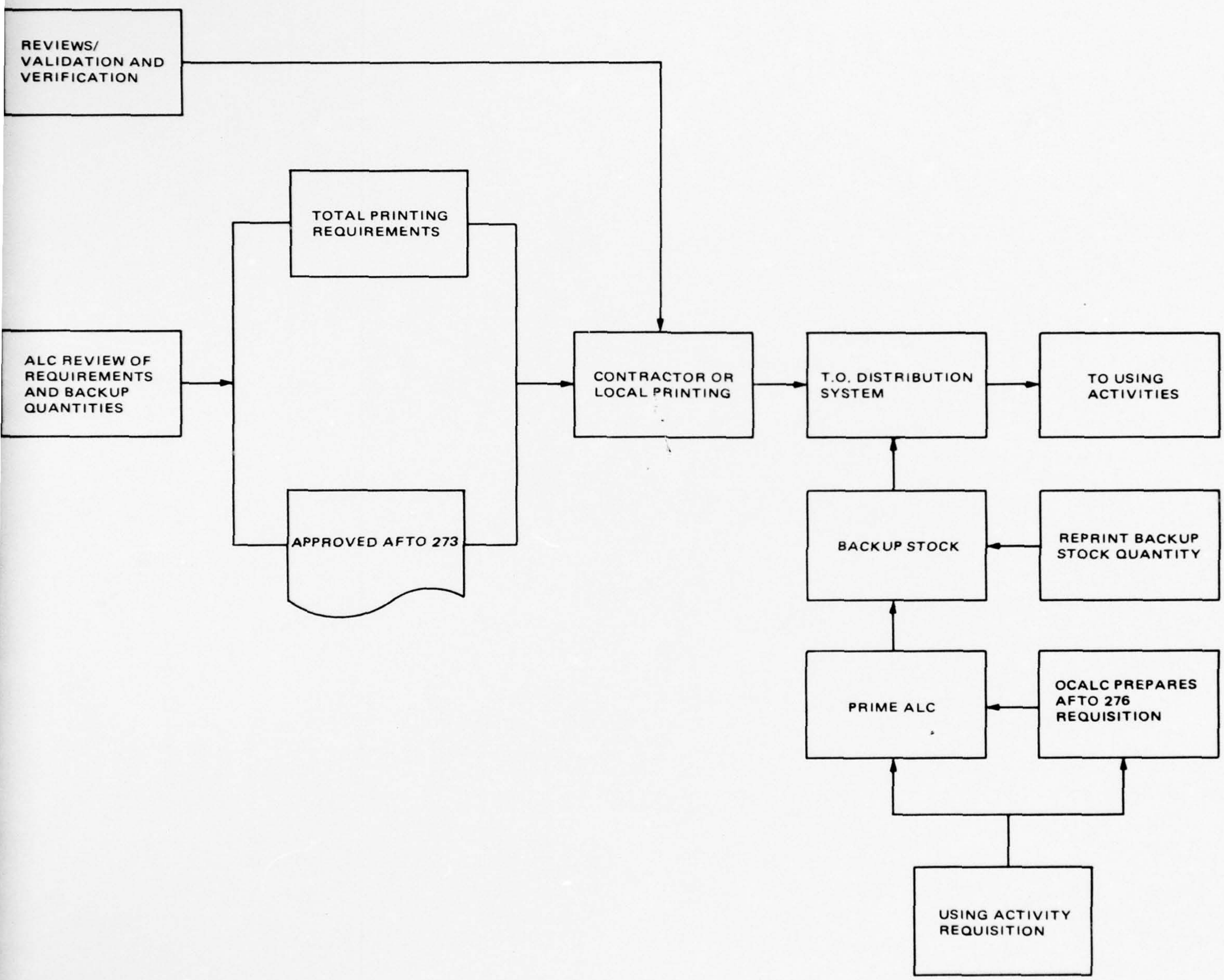

Figure 3-5. Air Force Technical Order System Acquisition Process. The Details of Air Force TO acquisition differ for various types of procurements, but the major functional elements remain the same.

3.2.1.4 SURVEY OF NAVY SPECIFICATION SYSTEMS

Fragmented control and issue of TM specifications in the Navy has resulted in the numerous and diverse documents which exist today. More than one (and sometimes many) specifications must be invoked to define TM requirements since very few of these documents, by themselves, are adequate in describing the complete requirements for any given technical manual.

Technical manual specification systems are a group of documents which collectively comprise the requirements and guidance for the generation of technical manuals. Their requirements may be invoked in whole or part, superseded by other specifications invoked in whole or part, and modified or cancelled in whole or part by other specifications.

Many TM specification systems are used by the Navy, of which only those most commonly used are described in this survey. Generally, NAVSEA and NAVELEX use the same specification systems, whereas NAVAIR uses systems of its own. An analysis was made of NAVSEA and NAVELEX specification systems for conventional manuals, for functionally oriented maintenance manuals (FOMM), and for maintenance requirement cards (MRCs) and maintenance index pages (MIPs) for the planned maintenance system (PMS). An analysis was also made of NAVAIR specification systems for conventional manuals, and for manuals prepared to the newer Work Package concept[1]. A tabulation of the specification systems is shown in Figure 3-6. A brief description of each system follows.

NAVSEA AND NAVELEX Specification Systems - The NAVSEA and NAVELEX specification system for conventional manuals uses MIL-M-15071G as the primary content specification. This specification covers most of the content requirements, and some of the style and format requirements. MIL-M-38784A is referenced for other style and format requirements, and MIL-P-38790 referenced for printing requirements. MIL-M-15071G covers the content requirements for five different types of manuals - Types I, II, IIS, IIX, and III - necessary for installation, operation, maintenance, and parts support for all NAVSEA cognizance equipment types. Type I manuals are for electrical and mechanical equipment; Types II, IIS, and IIX are for electronic and interior communications equipment, Type IIS covers service test equipment, and Type IIX covers experimental equipment; Type III covers system manuals.

The NAVSEA and NAVELEX specification system for overhaul manuals uses MIL-M-21742A as the primary content specification. This specification covers the requirements for manuals for depot level overhaul of electronic and interior communications equipment. The structure of this specification system is similar to that for conventional manuals, in that it uses a primary content specification to cover most of the content requirements and some of the style and format requirements, and uses MIL-M-38784A to cover the other style and format requirements.

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[1]NAVAIR 00-25-700, "Technical Manual Preparation Guide for Technical Writers, Editors, and Illustrators", Management and Procedures Manual, Preliminary, 1 June 1976

SPECIFICATION / DOCUMENT			EQUIPMENT AND SYSTEMS (CONVENTIONAL MANUALS)	EQUIPMENT AND SYSTEMS (FOMM MANUALS)	MRC'S AND MIP'S	OVERHAUL MANUALS	EQUIPMENT (CONVENT…	E…	
NUMBER	TITLE	DATE							
MIL-M-8910A	PREPARATION OF TECHNICAL MANUALS; IPB	4/72							
MIL-M-9868D MIL-M-9868/1A	35MM MICROFILMING OF ENGINEERING DOCUMENTS	10/70	●	●		●	●	●	
MIL-M-15071G	CONTENT REQUIREMENTS FOR EQUIPMENT AND SYSTEMS TECHNICAL MANUALS	11/73	○			●	○		
MIL-M-21742A	CONTENT REQUIREMENTS FOR TECHNICAL MANUALS; OVERHAUL OF ELECTRONIC AND IC EQUIPMENT	2/71	●			○	●		
MIL-M-23305	TECHNICAL MANUALS; MAINTENANCE, OVERHAUL, AND IPB FOR AIRCRAFT LAUNCHING AND RECOVERY EQUIPMENT	7/75							
MIL-M-23618E	PREPARATION OF PERIODIC MAINTENANCE REQUIREMENTS	11/75							
MIL-M-24100B	FUNCTIONALLY ORIENTED MAINTENANCE MANUALS (FOMM) FOR EQUIPMENT AND SYSTEMS	1/74		○		●		○	
MIL-M-24365A	MAINTENANCE ENGINEERING ANALYSIS PROCEDURES AND DOCUMENT REQUIREMENTS	7/70	●			●	●		
MIL-P-28759	PREPARATION AND CONTENTS OF MRC'S AND MIP'S	2/71							○
MIL-M-38784A	TECHNICAL MANUALS; GENERAL STYLE AND FORMAT REQUIREMENTS	9/75	●	●	●	●	●	●	●
MIL-P-38790	GENERAL REQUIREMENTS FOR PRINTING AND PRODUCTION OF TECHNICAL MANUALS	5/76	●	●		●	●	●	
MIL-M-81203A	IN-PROCESS REVIEWS, VALIDATION, AND VERIFICATION	12/67							
MIL-M-81260A	TECHNICAL MANUALS; AIRCRAFT/SYSTEM/EQUIPMENT MAINTENANCE	10/71							
MIL-M-81700	TECHNICAL MANUALS; AIRBORNE ARMAMENT EQUIPMENT	9/68							
MIL-M-81701B	TECHNICAL MANUALS; AIRBORNE MISSILES AND GUIDED WEAPONS (MICROFORM COMPATIBLE)	3/76							
MIL-M-81702A	TECHNICAL MANUALS; GENERAL AIRBORNE WEAPONS (CONVENTIONAL)	7/72							
MIL-M-81748A	RAPID ACTION CHANGES	7/75							
MIL-M-81919	TECHNICAL MANUALS; SUPPORT EQUIPMENT (MICROFORM COMPATIBLE)	7/73							
MIL-M-81927	GENERAL PREPARATION OF TECHNICAL MANUALS (MICROFORM COMPATIBLE)	2/75							
MIL-M-81928	TECHNICAL MANUALS; AIRCRAFT EQUIPMENT AND COMPONENT MAINTENANCE (MICROFORM COMPATIBLE)	2/75							
MIL-M-81929	TECHNICAL MANUALS; IPB'S (MICROFORM COMPATIBLE)	2/75							
MIL-M-81930	REQUIREMENTS FOR MICROFILM OF TECHNICAL MANUALS; 16MM MASTERS	2/74							
MIL-M-82527A	DEVELOPMENT AND PREPARATION OF MRC'S AND MIP'S	8/69			○				
AR-30	ILS REQUIREMENTS FOR AERONAUTICAL SYSTEMS AND EQUIPMENT	12/72							
WR65A	MAINTENANCE ANALYSIS AND DOCUMENTATION FOR SURFACE MISSILE SYSTEMS PMS/SMS	9/65			●				
WS4616	TECHNICAL MANUALS; PMS/SMS FOR SURFACE MISSILE SYSTEMS	3/66			●				
OPNAV INST 4790.2	NAVAIR MAINTENANCE PROGRAM	12/75							
NAVAIR 00-25-600	SUPPORT OF IN-PROCESS REVIEW, VALIDATION, AND VERIFICATION	7/69							
NAVAIR 00-25-700	TECHNICAL MANUAL PREPARATION GUIDE FOR WRITERS, EDITORS, AND ILLUSTRATORS	6/76							
NAVMAT INST 4790.5	MIP AND MRC STANDARDIZATION HANDBOOK	7/69			●				[illegible]
OPNAV INST 4790.4	MAINTENANCE AND MATERIAL MANAGEMENT MANUAL	2/76							[illegible]

Figure 3-6. Navy T
are arranged accord
in each column repr

		SPECIFICATION SYSTEM															
		NAVSEA				NAVELEX				NAVAIR							
										CONVENTIONAL				WORK PACKAGE			
T	DATE	EQUIPMENT AND SYSTEMS (CONVENTIONAL MANUALS)	EQUIPMENT AND SYSTEMS (FOMM MANUALS)	MRC'S AND MIP'S	OVERHAUL MANUALS	EQUIPMENT AND SYSTEMS (CONVENTIONAL MANUALS)	EQUIPMENT AND SYSTEMS (FOMM MANUALS)	MRC'S AND MIP'S	OVERHAUL MANUALS	LAUNCHING AND RECOVERY EQUIPMENT	SYSTEM/EQUIPMENT MAINTENANCE	ARMAMENT EQUIPMENT	AIRBORNE WEAPONS	MISSILES AND GUIDED WEAPONS	SUPPORT EQUIPMENT	EQUIPMENT AND COMPONENT MAINTENANCE	PERIODIC MAINTENANCE REQUIREMENTS (MRC'S)
	4/72									●	●	●					
MENTS	10/70	●	●		●	●	●		●								
ND	11/73	○			●	○			●								
ANUALS; NT	2/71	●			○	●			○								
HAUL, AND RY EQUIPMENT	7/75									○							
EQUIREMENTS	11/75																○
ANUALS (FOMM)	1/74		○		●		○		●								
CEDURES AND	7/70	●			●	●			●								
MIP'S	2/71							○									
FORMAT	9/75	●	●	●	●	●	●	●	●	●	●	●	●				
D	5/76	●	●		●	●	●		●	●	●	●	●				
IFICATION	12/67									●	●	●	●	●	●	●	●
UIPMENT	10/71										○						
T EQUIPMENT	9/68											○					
ND GUIDED	3/76													○			
WEAPONS	7/72												○				
	7/75									●							●
	7/73														○		
UALS	2/75													●	●	●	
T AND MPATIBLE)	2/75															○	
MPATIBLE)	2/75													●	●	●	
CAL	2/74													●	●	●	
AND MIP'S	8/69			○													
STEMS	12/72																●
TION FOR	9/65			●													
E	3/66			●													
	12/75																●
N,	7/69									●	●	●	●	●	●	●	●
R	6/76													●	●	●	
K	7/69			●				●									
T MANUAL	2/76							●									

LEGEND

○ PRIMARY CONTENT SPECIFICATION

● SUPPORTING SPECIFICATION OR DOCUMENT

Figure 3-6. Navy TM Specification Systems. Navy TM specification systems are arranged according to equipment and manual types. All documents contained in each column represent the TM specification system for that category of TM.

3.2.1.4 SURVEY OF NAVY SPECIFICATION SYSTEMS (Continued)

The NAVSEA and NAVELEX specification system for FOMM manuals uses MIL-M-24100B as the primary content specification. This specification contains nearly all of the requirements for FOMM manuals, but other specifications are referenced for only a few other requirements each. A preparation guide is available for use in preparing FOMM manuals (MIL-HDBK-242), but is not referenced in MIL-M-24100B. MIL-M-24100B covers the content requirements for manuals necessary for installation, operation, maintenance, and repair of electrical, electronic, mechanical, pneumatic, and hydraulic equipment and systems. MIL-M-24100B covers six different types of manuals; Types I, IS, IX, II, IIS, and IIX. Types I, IS, and IX are equipment manuals, whereas Types II, IIS, and IIX are system manuals. Types IS and IIS cover service test equipment and systems. Types IX and IIX cover experimental equipment and systems.

NAVSEA and NAVELEX use different specification systems for MRCs and MIPs. The NAVSEA specification system uses MIL-M-82527A as the primary specification for development and preparation of MRCs and MIPs. The NAVELEX specification system uses MIL-P-28759 as the primary specification for MRC and MIP preparation and content requirements. Both specification systems give guidance in the preparation of MRCs and MIPs, and both specification systems require a maintenance engineering analysis. The two specification systems are similar, but reference different documents as guides.

NAVAIR Specification Systems - NAVAIR uses four parallel specification systems for conventional manuals, and three separate parallel specification systems for manuals prepared to the newer Work Package concept. Each NAVAIR specification system for conventional manuals uses a primary content specification which sets forth all the content requirements for the manual. The primary content specifications reference MIL-M-38784A for all the style and format requirements, and MIL-M-81203A and NAVAIR 00-25-600 for quality assurance requirements and guidance. MIL-M-23305 is the primary content specification for conventional maintenance manuals for aircraft launching and recovery equipment; MIL-M-81260A is the primary content specification for conventional organizational, intermediate, and depot level maintenance manuals for aircraft systems, components, accessories, and ground support equipment; MIL-M-81700 is the primary content specification for conventional manuals for preloading and all levels of maintenance of airborne armament equipment; and MIL-M-81702A is the primary content specification for manuals for description, assembly, inspection, checkout, maintenance, and handling of conventional airborne weapons.

The NAVAIR specification systems for the Work Package manuals are similar to those for the conventional manual. However, the specification systems for Work Package manuals use MIL-M-81927 for the general style and format requirements. Like the specification systems for conventional manuals, the Work Package specification systems use MIL-M-81203A and NAVAIR 00-25-600 for the requirements and guidance for quality assurance. For Work Package manuals, MIL-M-81701B is the primary content specification for intermediate and depot level maintenance manuals for airborne missiles and guided weapons; MIL-M-81919 is the primary content specification for manuals for operation,

maintenance, and calibration of support equipment; and MIL-M-81928 is the primary content specification for maintenance manuals for aircraft systems, equipment, and components.

Analysis and Conclusions - The role of the TM specification system is to provide the requirements and the guidance necessary to produce TMs that enable the user to efficiently operate and/or maintain user commodities, and to provide the guidance necessary for the TM producer and the procuring agency to ascertain that the TMs meet these needs. An analysis of Navy specification systems was made to see how they fulfill this role. This analysis considers only the effectiveness of the specification systems in stating exact requirements for the manuals, and does not consider the relative merits of the different types and styles of technical manuals. The matrix shown in Figure 3-6 shows the effectiveness of each specification system in providing the requirements and guidance necessary for each major element of a technical manual. The effectiveness is rated on a three-point scale. A rating of 1 indicates that the requirement is inadequate, vague, or confusing. A rating of 2 indicates that the requirement is adequate but subject to interpretation. A rating of 3 indicates that the requirement is explicit. Some of the requirements are invoked only under certain conditions which are referenced to notes. These ratings are subjective, the opinion of evaluators who have over 150 years of cumulative experience in Hughes Aircraft Company, generating Technical Manuals to these specifications. In their opinion, this is how well the specifications describe to them the desired content and structure of the TM.

The NAVSEA and NAVELEX specification systems cover all equipment types in single primary content specifications, but content requirements of the specification are not sufficiently explicit for application to all equipment types. In many cases, it is up to the contractor to decide which type and style of data is applicable to which type of equipment. Because of the broad coverage of the primary content specifications, unique data requirements are not provided for unique equipment types. This type of specification structure also requires that the specification be constantly revised, as new equipment technologies emerge which require additional or new data requirements. On the other hand, the NAVAIR specification structure is such that each primary content specification covers a general class of equipment, and a set of core specifications is used for all of the general requirements. While this type of specification allows for unique data requirements for unique equipment classes, it is not easily adaptable to changes in equipment technology and promotes further generation of new specifications.

A review of the evaluation matrix of Navy specification systems in Figure 3-7 shows that all Navy specification systems are generally adequate in style and format requirements, although these requirements are subject to interpretation and do not assure that Navy manuals will be uniform in style and format. These fixed style and format requirements do not allow flexibility for different styles of manuals for different environments and different equipment types. It is recognized that contract documents such as Technical Manual Contract Requirements (TMCRs) and Data Item Descriptions (DIDs) do

3.2.1.4 SURVEY OF NAVY SPECIFICATION SYSTEMS (Continued)

permit the purchasing activity to tailor specification requirements to a limited degree. The Navy specification systems are generally detailed in their content requirements, but are subject to interpretation in their level and style of writing. Navy specification systems are weak in their provisions of sample text, tables, and illustrations. However, the NAVAIR specification system for Work Package manuals and MIL-M-24100B for FOMM manuals are well illustrated. All Navy specification systems have strong requirements for quality assurance programs and for validation and verification, but only the NAVAIR specification systems have adequate requirements for in-process reviews.

Overall, the Navy specification systems have adequate requirements to produce uniform manuals, but are inflexible and difficult to adapt to the unique requirements for different equipment types, for different tasks, and for different environments. The Navy specification systems do not adequately tie the manual requirements to a maintenance plan unless a maintenance plan is provided by the contract and invoked as a TM requirement. Except for the NAVAIR Work Package manuals, Navy specification systems do not contain adequate guidelines to assure that manuals are comprehensible by the user, and to assure that the manuals meet the user job requirements.

MANUAL REQUIREMENT / SPECIFICATION SYSTEM		NAVSEA/NAVELEX CONVENTIONAL MANUALS					NAVSEA/NAVALEX OVERHAUL MANUALS							NAVSEA/ NAVELEX FOMM MANUALS				NAVSEA MRC'S AND MIP'S					NAVELEX MRC'S AND MIP'S					LAUNCHING AND RECOVERY EQUIPM				
		MIL–M–9868/1A	MIL–M–15071G	MIL–M–24365A	MIL–M–38784A	MIL–P–38790	MIL–M–9868/1A	MIL–M–15071G	MIL–M–21742A	MIL–M–24100B	MIL–M–24365A	MIL–M–38784A	MIL–P–38790	MIL–M–9868D	MIL–M–24100B	MIL–M–38784A	MIL–P–38790	MIL–M–38784A	MIL–M–82527A	WS4616	WR65A	NAVMATINST 4790.5	MIL–M–15071G	MIL–M–28759	MIL–M–38784A	NAVMATINST 4790.5	OPNAV INST 4790.2	MIL–M–8910A	MIL–M–23305	MIL–M–38784A	MIL–P–38790	MIL–M–81203A
STYLE AND FORMAT	GENERAL REQUIREMENTS		2		2				2			2			2			2	2	2			1	1		1			2	2		
	TYPOGRAPHY		3		3							3			3				3											3		
	PRINTING					3							3		3																	
	LITHOGRAPHIC NEGATIVES					3							B		3		3														3	
	MANUAL/PAGE SIZE				3							3			3															3		
	MANUAL DIVISIONS		2		2				3						3															2		
	NUMBERING				2										2	2														2		
	APPENDIXES		3		3							C																				
	INDEX		2		2							2																	2			
	REFERENCES		2						2										3													
	ILLUSTRATION REQUIREMENTS		2		2			1	1	1		1			2				2					2	2					2		
	CHANGES/REVISIONS		3		3			1	1	1		1			3	3			2										3	3		
	SUPPLEMENTS											2			1	2																
	MICROFORM COMPATABILITY	3	3				3							3	3	3																
CONTENT	FRONT MATTER		3		3				3			3			3	3													3	3		
	BOOKPLAN (OUTLINE)		3	A	3				3		A				1																	
	MAINTENANCE PLAN		2	A					E		A								2			R		3								
	DATA CONTENT		2	A					2	2					2				2		R			3			R		2			
	PARTS LIST		3						2						3													3	3			
	ILLUSTRATION/DIAGRAM USE		2						2						2				2					2					1			
	SAMPLE TEXT														1																	
	SAMPLE TABLES		2						2						2														2			
	SAMPLE ILLUSTRATIONS		2						2						3														2			
	PREPARATION GUIDE														D				2					3								
READABILITY/ COMPREHENSIBILITY	JOB RELEVENCY								2										2					2								
	INFORMATION COMPRESSION														3				3					3								
	LEVEL OF WRITING		2						1						2	2			2										1	2		
	STYLE OF WRITING				1										2				2											2		
	READABILITY REQUIREMENTS																															
	VOCABULARY GUIDE																							3								
QUALITY ASSURANCE	QUALITY PROGRAM		3					3							3				G					1								3
	IN PROCESS REVIEW		1					1							1																	3
	VALIDATION/VERIFICATION		3					3							3									2								3
	VALIDATION OF READABILITY																															
	APPROVAL AND ACCEPTANCE		3												3									1						3		
	PREPARATION FOR DELIVERY		3						3						3			3	3				3						3	3		

	NAVELEX MRC'S AND MIP'S					NAVAIR CONVENTIONAL MANUALS																								NAVAIR WORK PACKAGE MANUALS														
						LAUNCHING AND RECOVERY EQUIPMENT							MAINTENANCE SYSTEMS/EQUIPMENT						ARMAMENT EQUIPMENT						AIRBORNE WEAPONS					MISSILES AND GUIDED WEAPONS							SUPPORT EQUIPMENT						EQ CO	
4790.5	MIL-M-15071G	MIL-M-28759	MIL-M-38784A	NAVMATINST 4790.5	OPNAV INST 4790.2	MIL-M-8910A	MIL-M-23305	MIL-M-38784A	MIL-P-38790	MIL-M-81203A	MIL-M-81748A	NAVAIR 00-25-600	MIL-M-8910A	MIL-M-38784A	MIL-P-38790	MIL-M-81203A	MIL-M-81260A	NAVAIR 00-25-600	MIL-M-8910A	MIL-M-38784A	MIL-P-38790	MIL-M-81203A	MIL-M-81700	NAVAIR 00-25-600	MIL-M-38784A	MIL-P-38790	MIL-M-81203A	MIL-M-81702A	NAVAIR 00-25-600	MIL-M-81203A	MIL-M-81701B	MIL-M-81927	MIL-M-81929	MIL-M-81930	NAVAIR 00-25-600	NAVAIR 00-25-700	MIL-M-81203A	MIL-M-81919	MIL-M-81927	MIL-M-81929	MIL-M-81930	NAVAIR 00-25-600	MIL-M-81203A	MIL-M-81927
	1	1		1			2	2									2			2								2			2	2							2					2
								3						3						3					3							3							3					3
															3						3					3																	
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																																	3							3			
							3	3						3						3					3							3							3					3
																															1							1					1
R		3															1														E													
		3			R		2										1						2					2			2							2						
						3	3						3						3													3							3				
		2					1										3											2			3	3						3	3					3
																															3						3	3					3
							2															2						2				3						3	3					3
							2										2						3				3					3						3	3					3
		3																																		R		D						D
		2																												2						R								
		3																												2						R								
							1	2									1						2					2				1					R		1						
								2						1						1					1							3					R		3	3					3
		3																													3							3					3
		1								3		3				3		3				3		3			3		3	3					3		3					3	3	
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		2								3		3				3		3				3		3			3		3	3					3		3					3	3	
		1						3								3						3								3					3		3	3				3	3	3
	3						3	3						3																	2							2					[illegible]

Figure 3
represen
of each

NAVAIR WORK PACKAGE MANUALS																			NAVAIR MRC'S						
MISSILES AND GUIDED WEAPONS							SUPPORT EQUIPMENT						EQUIPMENT AND COMPONENTS						PERIODIC MAINTENANCE REQUIREMENTS (MRC'S)						
MIL-M-8120	MIL-M-81701B	MIL-M-81927	MIL-M-81929	MIL-M-81930	NAVAIR 00-25-600	NAVAIR 00-25-700	MIL-M-81203A	MIL-M-81919	MIL-M-81927	MIL-M-81929	MIL-M-81930	NAVAIR 00-25-600	MIL-M-81203A	MIL-M-81927	MIL-M-81928	MIL-M-81929	MIL-M-81930	NAVAIR 00-25-600	MIL-M-23618E	MIL-P-38790	MIL-M-81203A	MIL-M-81748A	NAVAIR 00-25-600	CPNAV INST 4790.2	AR-30
	2	2							2					2					2						
		3							3					3					3						
																				3					
																				3					
		3							3					3					3						
		3						3	3					3	2				3						
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	3	3							3					3					2						
		3							3					3					G			G			
		2							2					2											
				3							3						3								
		3							3					3											
		1							1					1											
	E																							2	A
	2							2							2				2						
			3							3						3									
	3	3						3	3					3	3				3						
		3						3	3					3	3				3						
		3						3	3					3	3				3						
		3						3	3					3	3				3						
						R		D						D					D						
	2					R																			
	2					R																			
		1				R		1							1				1						
		3				R		3	3					3					2						
		3							3					3											
3					3		3					3	3					3			3		3		
3					3		3					3	3					3			3		3		
3					3		3					3	3					3			3		3		
3					3		3	3				3	3	3	3			3	3		3		3		
		2							2					2					3						

LEGEND

1 VAGUE, INADEQUATE, OR CONFUSING

2 ADEQUATE BUT SUBJECT TO INTERPRETATION

3 EXPLICIT

A IF INVOKED BY CONTRACT

B IF REQUIRED BY PROCURING AGENCY

C IF AUTHORIZED BY PROCURING AGENCY

D AVAILABLE BUT NOT REFERENCED IN PRIMARY SPECIFICATION

E SUPPLIED BY PROCURING AGENCY

G PER CONTRACT

R FOR REFERENCE

Figure 3-7. Survey of Navy Specification Systems. An evaluation of representative Navy TM specification systems showing the effectiveness of each system in providing Navy TM requirements.

3.2.1.5 SURVEY OF ARMY SPECIFICATION SYSTEMS

In the past few years, the Army has made notable progress in consolidating and eliminating TM specifications under the Defense Standardization Program (DoD 4120.3-M), and projects are presently underway to further improve TM specifications for various types of Army manuals. Though Army specification systems are tightly structured, they still exhibit many of the problems of those in the Navy and Air Force.

The Army uses a different specification system for each general class of equipment. All of the specification systems use a core set of specifications which set forth the general style and format requirements, and the requirements for certain types of contents which are common to all equipment types. A tabulation of the Army specification systems by equipment types is given in Figure 3-8.

The unique content requirements for each equipment class are set forth by the content specification for the equipment class. The content specification is the primary specification. The general style and format requirements for the manuals for each equipment class are provided by MIL-M-38784A. This specification also contains limited readability requirements. MIL-M-38784A is directly referenced by the primary content specifications for a few of the style and format requirements. In most cases, to make MIL-M-38784A the governing specification for all style and format requirements, it must be invoked by the contract. Some content specifications reference MIL-M-63000C for the general style and format requirements; however, MIL-M-63000C has been superseded by MIL-M-38784A. MIL-M-63001E sets forth the requirements for repair parts and special tools lists required in some manuals and MIL-M-63050 sets forth the requirements for components of end item, basic issue items, additional authorization, and expendable supplies and materials lists.

The matrix in Figure 3-9 shows the effectiveness of each Army specification system in providing the requirements and guidance necessary for major technical manual needs. The effectiveness is rated on a three-point scale. A rating of 1 indicates that the requirement is inadequate, vague, or confusing. A rating of 2 indicates that the requirement is adequate, but subject to interpretation. A rating of 3 indicates that the requirement is explicit. Some of the requirements are invoked only under certain conditions, which are referenced to notes. These ratings are subjective, the opinion of evaluators who have over 150 years of cumulative experience in Hughes Aircraft Company, generating technical manuals to these specifications. In their opinion, this is how well the specifications describe to them the desired content and structure of the TM.

The structure of the Army specification systems allows for unique data requirements for different general classes of equipment. However, the specification systems are not particularly task-oriented, because requirements for operation and all levels of maintenance are contained in a single specification system. A study of the evaluation matrix in Figure 3-8 indicates that the Army specification systems are generally adequate in the general style and format requirements. However, except for the specification system for

SPECIFICATION/DOCUMENT

NUMBER	TITLE	DATE	MECHANICAL AND CONSTRUCTION EQUIPMENT, AUTOMOTIVE EQUIPMENT, AND POWER TOOLS	MUNITIONS EQUIPMENT	TELECOMMUNICATIONS EQUIPMENT	RADAR EQUIPMENT	AIRCRAFT ELECTRONICS EQUIPMENT	PHOTOGRAPHIC, MOTION PICT AND RECORDING EQUIPMEN	ELECTRONIC TEST	AIRCRA	
MIL-M-38748A	REQUIREMENTS FOR MICROFICHE	12/70									
MIL-M-38784A	TECHNICAL MANUALS; GENERAL REQUIREMENTS	9/75	●	●	●	●	●	●	●	●	●
MIL-M-63000C	TECHNICAL MANUALS; GENERAL REQUIREMENTS FOR MANUSCRIPTS	9/71			●		●	●	●		●
MIL-M-63001E	TECHNICAL MANUALS; REPAIR PARTS AND SPECIAL TOOLS LIST	12/75	●	●	●	●	●	●	●		●
MIL-M-63004B	TECHNICAL MANUALS; PREPARATION OF LUBRICATION ORDERS	5/76				●					
MIL-M-63009C	TECHNICAL MANUALS; MECHANICAL AND CONSTRUCTION EQUIPMENT, AUTOMOTIVE EQUIPMENT, AND POWER TOOLS	6/76	○								
MIL-M-63016	TECHNICAL MANUALS; MUNITIONS EQUIPMENT	11/75		○							
MIL-M-63019	TECHNICAL MANUALS; TELECOMMUNICATIONS EQUIPMENT	6/76			○						
MIL-M-63020A	TECHNICAL MANUALS; RADAR EQUIPMENT	8/76				○					
MIL-M-63022	TECHNICAL MANUALS; AIRCRAFT ELECTRONIC EQUIPMENT	11/75					○				
MIL-M-63024	TECHNICAL MANUALS; PHOTOGRAPHIC, MOTION PICTURE, SOUND, AND RECORDING EQUIPMENT	11/75						○			
MIL-M-63025	TECHNICAL MANUALS; ELECTRONIC TEST EQUIPMENT	11/75							○		
MIL-M-63026A	TECHNICAL MANUALS; ARMY AIRCRAFT MAINTENANCE	12/75								○	
MIL-M-63027	TECHNICAL MANUALS; MAINTENANCE AND OVERHAUL OF AERONAUTICAL ACCESSORIES AND SUPPORT EQUIPMENT	7/71									○
MIL-M-63028	TECHNICAL MANUALS; MAINTENANCE REQUIREMENTS FOR MAINTENANCE OF AIRCRAFT ENGINES AND ACCESSORIES	9/69									
MIL-M-63030B	PREVENTIVE MAINTENANCE MANUALS	5/73			●	●		●	●		
MIL-M-63032B	TECHNICAL MANUALS; WEAPONS COMBAT VEHICLES, AND FIRE CONTROL MATERIAL	6/76									
MIL-M-63036	PREPARATION OF OPERATOR'S TECHNICAL MANUALS	5/76									
MIL-M-63043	TECHNICAL MANUALS; MISSILE SYSTEM EQUIPMENT CHECK PROCEDURES	5/70									
MIL-M-63044	TECHNICAL MANUALS; MISSILE SYSTEM EQUIPMENT UNIT UNDER TEST PROCEDURES	3/76									
MIL-M-63046	TECHNICAL MANUALS; MISSILE SYSTEM EQUIPMENT	11/75									
MIL-M-63048A	PREPARATION OF EQUIPMENT PUBLICATIONS ON MICROFICHE	9/74									
MIL-M-63050	COMPONENTS OF END ITEM, BASIC ISSUE ITEMS, ADDITIONAL AUTHORIZATION, AND EXPENDABLE SUPPLIES LISTS	5/76	●		●	●					
TM 38-750	ARMY MAINTENANCE MANAGEMENT SYSTEM (JAMMS)	11/72	●	●	●		●	●	●	●	●
TM 55-405-9	ARMY AVIATION MAINTENANCE ENGINEERING MANUAL	8/66								●	
TM 55-1500-204-25/1	GENERAL AIRCRAFT MAINTENANCE MANUAL	4/70			●	●		●	●	●	
TM 55-1500-328-25	AERONAUTICAL EQUIPMENT MAINTANANCE MANAGEMENT POLICIES AND PROCEDURES	7/72								●	
AR750-1	ARMY MATERIAL MAINTENANCE CONCEPTS AND POLICIES	5/72								●	

Figure 3-8. Army TM Sp
are arranged according
column represent the TM

DATE	MECHANICAL AND CONSTRUCTION EQUIPMENT, AUTOMOTIVE EQUIPMENT, AND POWER TOOLS	MUNITIONS EQUIPMENT	TELECOMMUNICATIONS EQUIPMENT	RADAR EQUIPMENT	AIRCRAFT ELECTRONICS EQUIPMENT	PHOTOGRAPHIC, MOTION PICTURE, SOUND, AND RECORDING EQUIPMENT	ELECTRONIC TEST EQUIPMENT	AIRCRAFT MAINTENANCE	AERONAUTICAL ACCESSORIES AND SUPPORT EQUIPMENT, MAINTENANCE AND OVERHAUL	AIRCRAFT ENGINES AND ACCESSORIES, MAINTENANCE	WEAPONS, COMBAT VEHICLES, AND FIRE CONTROL MATERIAL	MISSILE SYSTEMS: EQUIPMENT CHECK PROCEDURES	MISSILE SYSTEMS: UNIT UNDER TEST PROCEDURES	MISSILE SYSTEMS: EQUIPMENT	OPERATORS MANUALS (ALL EQUIPMENT TYPES EXCEPT AIRCRAFT)	MICROFICHE MANUALS
12/70																●
9/75	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
9/71			●		●	●	●		●	●		●	●	●		●
12/75	●	●	●	●	●	●	●		●	●	●			●		
5/76				●							●				●	
6/76	○															
11/75		○														
6/76			○													
8/76				○												
11/75					○											
11/75						○										
11/75							○									
12/75								○		●						
7/71									○							
9/69										○						
5/73			●	●		●	●									
6/76											○					
5/76															○	
5/70												○		●		
3/76													○	●		
11/75														○		
9/74																○
5/76	●		●	●							●				●	
11/72	●	●	●		●	●	●	●	●					●	●	
8/66								●								
4/70			●	●		●	●	●								
7/72								●								
5/72								●								

EQUIPMENT TYPES

LEGEND

○ PRIMARY CONTENT SPECIFICATION

● SUPPORTING SPECIFICATION OR DOCUMENT

Figure 3-8. Army TM Specification Systems. Army TM specification systems are arranged according to equipment types. All documents contained in each column represent the TM specification system for that category of TM.

operators' manuals which is governed by MIL-M-63036, the style and format requirements are subject to interpretation and do not assure manuals that are uniform in style and format.

The Army specification systems are generally weak in data content requirements, and the requirements in some specifications are little more than an outline. The Army specification systems are inadequate in the requirements for level of writing, and weak in the requirements for style of writing. Most of the Army specification systems lack samples of text although most contain adequate samples of tables and illustrations. Only two of the Army specification systems have preparation guides which help the technical writer with his preparation of data. However, all of the Army specification systems have, as prescribed by MIL-M-38784A, requirements for readability and validation of readability.

The quality assurance provisions of some of the Army specification systems are somewhat confusing at present. Originally, all of the quality assurance provisions were contained in MIL-M-63000C and then in MIL-M-38784A However, these specifications were superseded by MIL-M-38784A which does not contain the quality assurance provisions of in-process review, validation, and verification. These detailed quality assurance provisions are spelled out in some of the primary content specifications, but other primary content specifications have "not applicable" in their quality assurance provisions. In the specification systems where the primary content specification quality assurance requirements say "not applicable," reliance is placed on MIL-M-38784A for these provisions, and all of the provisions are not in MIL-M-38784A. This points up a problem that is inherent in all specification systems that reference other specifications for some of the requirements. The referenced specification may change in such a manner that the referenced requirements are no longer applicable, or become inadequate.

The preparation of Army technical manuals is tied to the maintenance allocation chart (MAC) for maintenance requirements. However, the MAC is normally procured as a separate contract item and is not usually updated concurrently with the preparation and updating of the technical manual.

MANUAL REQUIREMENT \ SPECIFICATION SYSTEM		MECH AND CONSTR EQPT, AUTOMOTIVE EQPT AND PWR TOOLS				MUNITIONS EQUIPMENT			TELECOMMUNICATIONS EQUIPMENT						RADAR EQUIPMENT						AIRCRAFT ELECTRONIC EQUIPMENT			
		MIL–M–38784A	MIL–M–63001E	MIL–M–63009C	MIL–M–63050	MIL–M–38784A	MIL–M–63001E	MIL–M–63016	MIL–M–38784A	MIL–M–63000C	MIL–M–63001E	MIL–M–63019	MIL–M–63030B	MIL–M–63050	MIL–M–38784A	MIL–M–63001E	MIL–M–63004B	MIL–M–63020A	MIL–M–63030B	MIL–M–63050	MIL–M–38784A	MIL–M–63000C	MIL–M–63001E	MIL–M–63022
STYLE AND FORMAT	GENERAL REQUIREMENTS	2		2		2		2	2			2			2			2			2			2
	TYPOGRAPHY	3				3			3						3						3			
	PRINTING																							
	LITHOGRAPHIC NEGATIVES																							
	MANUAL/PAGE SIZE	3				3			3						3						3			
	MANUAL DIVISIONS	2				2			2			3			2						2			
	NUMBERING	2				2			2						2						2			
	APPENDIXES	3	3	3	3	3	3	3	3	3	3			3	3	3				3	3	3	3	
	INDEX	2				2			2						2						2	2		
	REFERENCES	2				2			2						2						2			
	ILLUSTRATION REQUIREMENTS	2				2			2						2						2	2		
	CHANGES/REVISIONS	3				3			3						3						3			
	SUPPLEMENTS	2				2			2						2						2			
	MICROFORM COMPATABILITY			C				C				C						C						C
CONTENT	FRONT MATTER	3		3		3		3	3	3					3						3	3		
	BOOKPLAN (OUTLINE)	3				3			3						3						3			
	MAINTENANCE PLAN			B				B				B						B						B
	DATA CONTENT			1				1				2	2				3	2	2					1
	PARTS LIST		3				3				3					3							3	
	ILLUSTRATION/DIAGRAM USE			1								2					3	2						2
	SAMPLE TEXT																							
	SAMPLE TABLES			2				2				2	3				3	2	3					2
	SAMPLE ILLUSTRATIONS	2		1		2			2			2	2		2		3	2	2		2			3
	PREPARATION GUIDE																							
READABILITY/ COMPREHENSIBILITY	JOB RELEVENCY																							
	INFORMATION COMPRESSION																							
	LEVEL OF WRITING	1		1		1		1	1						1			1			1			1
	STYLE OF WRITING	2				2			2						2			1			2			1
	READABILITY REQUIREMENTS	3				3			3	3					3						3			
	VOCABULARY GUIDE																							
QUALITY ASSURANCE	QUALITY PROGRAM			3				3	1	3								3			D			
	IN-PROCESS REVIEW			3				3	D									3			D			
	VALIDATION/VERIFICATION			3				3		3								3				3		
	VALIDATION OF READABILITY	3				3			3	3					3						3			
	APPROVAL AND ACCEPTANCE			3		D			D						D						D			
	PREPARATION FOR DELIVERY	3				3			3						3						3			

NS	RADAR EQUIPMENT						AIRCRAFT ELECTRONIC EQUIPMENT				PHOTOGRAPHIC, MTN PICTURE, SOUND, AND RECORDING EQPT					ELECTRONIC TEST EQUIPMENT					AIR-CRAFT MAINT		AERONAUTICAL AND SUPPORT EQUIPMENT				AIRCRAFT ENGINES AND ENGINE ACCESSORIES					WEAPONS, COMBAT VEHICLES, AND FIRE CONTROL MATERIAL					MISSILE SYSTEM							
																																					EQUIPMENT CHECK PROC			EQUIPMENT UNDER TEST PROC			EQUIP	
MIL-M-63050	MIL-M-38784A	MIL-M-63001E	MIL-M-63004B	MIL-M-63020A	MIL-M-63030B	MIL-M-63050	MIL-M-38784A	MIL-M-63000C	MIL-M-63001E	MIL-M-63022	MIL-M-38784A	MIL-M-63000C	MIL-M-63001E	MIL-M-63024	MIL-M-63030B	MIL-M-38784A	MIL-M-63000C	MIL-M-63001E	MIL-M-63025	MIL-M-63030B	MIL-M-38784A	MIL-M-63026A	MIL-M-38784A	MIL-M-63000C	MIL-M-63001E	MIL-M-63027	MIL-M-38784A	MIL-M-63000C	MIL-M-63001E	MIL-M-63026A	MIL-M-63028	MIL-M-38784A	MIL-M-63001E	MIL-M-63004B	MIL-M-63032B	MIL-M-63050	MIL-M-38784A	MIL-M-63000C	MIL-M-63043	MIL-M-38784A	MIL-M-63000C	MIL-M-63044	MIL-M-38784A	MIL-M-63000C
	2			2			2			2	2			2		2			2		2	2	2	2			2	2			2	2			2		2		2	2		2	2	
	3						3				3					3					3		3				3					3					3			3			3	
	3						3				3					3					3		3				3					3					3			3			3	
	2						2				2					2					2	3	2			3	2			3	3	2			3		2			2			2	
	2						2				2					2					2		2				2					2					2			2			2	
3	3	3				3	3	3	3		3	3	3			3	3	3			3	2	3	3	3	3	3	3	3		3	3			3	3	3			3			3	
	2						2	2			2	2				2					2		2				2					2					2			2			2	2
	2						2				2					2					2		2				2					2					2			2			2	
	2						2	2			2					2					2		2				2					2					2			2			2	
	3						3				3					3					3	3	3				3					3					3			3			3	
	2						2				2					2					2		2				2					2					2			2			2	
				C						C				C					C			C				C					C				C									
	3						3	3			3	3				3	3				3		3	3			3	3				3					3	3		3	3		3	3
	3						3				3					3							3				3					3					3			3			3	
				B						B				B					B			B									B				B									
			3	2	2					1				2	2				2	2		2				2				2	2			3	2				1			2		
		3							3				3					3							3	3			3				3											
			3	2						2									2			3				1					2				2							2		
																																			2				2					
			3	2	3					2				1	3				[illegible]	3		3				3								3	3				2			3		
	2		3	2	2		2			3	2			3	2	2			2	2	2	3	2				2					2		3	3		2		1	2		2	2	
																																			2									
	1			1			1			1	1			1		1			1		1		1			1	1			1	1	1			1		1			1			1	
	2			1			2			1	2			1		2			1		2		2			1	2			1	1	2			2		2			2			2	
	3						3				3					3					3		3				3					3					3			3			3	
				3			D				D					D				1	D		D				D								3		D			D			D	
				3			D				D					D					D		D				D								3		D			D			D	
				3				3				3					3				D			3				3							3			3			3			3
	3						3				3					3					3		3				3					3			3		3			3			3	
	D						D				D					D					D		D				D								3		D			D			D	
	3						3				3					3					3		3				3					3					3			3			3	

Figure 3-9. Survey
representative Army
of each system in pr

NES		WEAPONS, COMBAT VEHICLES, AND FIRE CONTROL MATERIAL					MISSILE SYSTEMS												OPERATORS MANUALS			
							EQUIPMENT CHECK PROC			EQUIPMENT UNDER TEST PROC			EQUIPMENT MANUALS									
	MIL–M–63028	MIL–M–38784A	MIL–M–63001E	MIL–M–63004B	MIL–M–63032B	MIL–M–63050	MIL–M–38784A	MIL–M–63000C	MIL–M–63043	MIL–M–38784A	MIL–M–63000C	MIL–M–63044	MIL–M–38784A	MIL–M–63000C	MIL–M–63001E	MIL–M–63043	MIL–M–63044	MIL–M–63046	MIL–M–38784A	MIL–M–63004B	MIL–M–63036	MIL–M–63050
	2	2			2		2		2	2		2	2					2	2		2	
		3					3			3			3						3		3	
		3					3			3			3								A	
[illegible]	3	2			3		2			2			2						2		3	
		2					2			2			2						2		3	
	3	3			3	3	3			3			3					3			3	3
		2					2			2			2	2					2		3	
		2					2			2			2								3	
		2					2			2			2						2		3	
		3					3			3			3						3			
		2					2			2			2									
	C				C																C	
		3					3	3		3	3		3	3							3	
		3					3			3			3						3			
	B				B																B	
2	2			3	2				1			2				1	2	1		3	3	
			3												3							
	2				2							2									3	
					2				2												2	
				3	3				2			3						1			3	
		2		3	3		2		1	2		2	2					1			3	
					2																2	
																					2	
																					2	
1	1	1			1		1			1			1								3	
1	1	2			2		2			2			2								3	
		3					3			3			3						3			
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					3		D			D			D								3	
					3		D			D			D								3	
					3			3			3			3							3	
		3			3		3			3			3						3			
					3		D			D			D								3	
		3					3			3			3						3			

LEGEND

1 VAGUE, INADEQUATE, OR CONFUSING

2 ADEQUATE BUT SUBJECT TO INTERPRETATION

3 EXPLICIT

A AS SPECIFIED BY PROCURING AGENCY

B PROVIDED BY MAINTENANCE ALLOCATION CHART (MAC)

C WHEN REQUIRED BY PROCURING AGENCY

D QUALITY ASSURANCE PROVISIONS ARE CONFUSING. ORIGINALLY ALL QUALITY ASSURANCE PROVISIONS WERE CONTAINED IN MIL–M–38784A(TM). THIS SPECIFICATION WAS SUPERSEDED BY MIL–M–38784A WHICH DOES NOT CONTAIN THE SAME QUALITY ASSURANCE REQUIREMENTS

Figure 3-9. Survey of Army Specification Systems. An evaluation of representative Army TM specification systems showing the effectiveness of each system in providing Army TM requirements.

3

3.2.1.6 SURVEY OF AIR FORCE SPECIFICATION SYSTEMS

Like the Army, the control, update and generation of Air Force specifications has evolved into a more centralized and coordinated activity. Also like the Army and Navy, the profusion of Air Force specification systems still exist.

The structure of Air Force specification systems is similar to that of Army specification systems. Like the Army specification systems, the Air Force specification systems all use a core set of specifications for general style, for format requirements, and for certain types of contents which are common to all technical manuals. The Air Force specification systems also uses a unique primary content specification for each specification system. However, whereas the Army uses a unique content specification for each general class of equipment which covers the requirements for operation and all levels of maintenance, the Air Force uses a variety of content specifications that cover operation and/or different levels or combinations of levels of maintenance for different general classes of equipment. Representative samples of some of the most-used Air Force specification systems are tabulated in Figure 3-10.

The Air Force uses specification systems for different tasks such as operation, different levels of maintenance, repair, and overhaul, and for different reference data such as lubrication requirements, inspection requirements, and maintenance requirements. All of the specification systems rely mainly on MIL-M-38784A for general style and format requirements. Air Force specification systems cover four broad classes of equipment; aircraft, missiles, ground communication-electronics-meteorology (C-E-M) equipment, and support equipment. Some of the same specification systems are used under more than one of these broad categories of equipment types.

The matrix in Figure 3-11 shows the effectiveness of each representative Air Force specification system in providing the requirements and guidance necessary for each major technical manual need. The effectiveness is rated on a three-point scale. A rating of 1 indicates that the requirement is inadequate, vague, or confusing. A rating of 2 indicates that the requirement is adequate but subject to interpretation. A rating of 3 indicates that the requirement is explicit. These ratings are subjective, the opinion of evaluators who have over 150 years of cumulative experience in Hughes Aircraft Company, generating technical manuals to these specifications. In their opinion, this is how well the specifications describe to them the desired content and structure of the TM.

A review of Figure 3-11 shows that Air Force specification systems are adequate in style and format requirements and in the required data content, although these requirements are subject to interpretation. However, Air Force specification systems are inadequate in specifying the level of writing and are somewhat weak in specifying the style of writing. Most of the specification systems do not contain adequate samples of text, tables, and illustrations. Air Force specification systems have no readability requirements, and only one specification system has a vocabulary guide. The Air Force specification systems are weak in quality assurance provisions, and most

SPECIFICATION			AIRCRAFT													
NUMBER	TITLE	DATE	INSP & MAINT REQTS MNL & WORK CARDS ACPT & FUNCTIONAL CHK FLIGHT PROC CHK LISTS	COMMERCIAL EQUIPMENT	STRUCTURAL REPAIR	OVERHAUL AND INTERMEDIATE MAINTENANCE: ENGINES	SCHEMATIC BLOCK DIAGRAMS AND MAINTENANCE DEPENDENCY CHARTS	ORGANIZATIONAL MAINTENANCE (AIRCRAFT)	ILLUSTRATED PARTS BREAKDOWN	INSP & MAINT REQTS MNL & WORK CARDS ACPT & FUNCTIONAL CHK FLIGHT PROC CHK LISTS	ASSY SERVICING & ORGANIZATIONAL MAINTENANCE: MISSILES & PILOTLESS AIRCRAFT	INTERMEDIATE AND DEPOT OVERHAUL: MISSILE AND SPACE SYSTEM COMPONENTS	INTERMEDIATE MAINTENANCE AND OVERHAUL: ENGINES	CHECKLISTS	OPERATION ICBM	IN
MIL-M-5096	INSPECTION AND MAINTENANCE REQUIREMENTS MANUALS AND WORK CARDS, CHECK FLIGHT PROCEDURE, INSPECTION CHART	4/76	○							○						
MIL-M-5166C	TECH MANUALS; ASSEMBLY SERVICING AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS (GUIDED MISSILES AND PILOTLESS AIRCRAFT)	4/75									○					
MIL-M-7298C	TECH MANUALS; COMMERCIAL EQUIPMENT	4/75		○												
MIL-M-9854B	STRUCTURAL REPAIR (AIRCRAFT)	3/75			○											
MIL-C-9883B	ORGANIZATIONAL MAINTENANCE CHECKLIST (BM)	8/69												○	●	
MIL-M-9891A	INTERMEDIATE AND DEPOT OVERHAUL (MISSILES AND RELATED EQUIP)	6/75										○				
MIL-M-9910A	OPERATION AND MAINTENANCE INSTRUCTIONS WITH PARTS BREAKDOWN (QRC EQUIPMENT)	2/74														
MIL-C-9927A	ORGANIZATIONAL MAINTENANCE CHECKLIST	10/69						●								
MIL-M-24100B	FUNCTIONALLY ORIENTED MAINTENANCE MANUALS (FOMM)	1/74														
MIL-M-25095A	INTERMEDIATE MAINTENANCE: AVIONICS EQUIPMENT AND SYSTEMS	1/71														
MIL-M-25393A	INTERMEDIATE MAINTENANCE: AIRBORNE EQUIPMENT	2/75														
MIL-M-25394A	INTERMEDIATE MAINTENANCE AND OVERHAUL (ENGINES)	10/71				○							○			
MIL-M-26788C	OPERATION AND OPERATOR MAINTENANCE (AUTOMOTIVE EQUIPMENT)	2/74														
MIL-M-38311A	OPERATION AND ASSOCIATED CHECKLIST: ICBM	6/74													○	
MIL-M-38701	INSPECTION REQUIREMENT MANUALS AND WORK CARDS: MISSILE AND SPACE WEAPON SYSTEMS	3/64														○
MIL-M-38777A	INSPECTION, LUBRICATION, AND MAINTENANCE REQUIREMENT MANUALS AND WORK CARDS: CEM EQUIPMENT	8/71														
MIL-C-38778A	CHECKLISTS: TITLE PAGE, LIST OF EFFECTIVE PAGES, PRINTING AND BINDERS	7/74						●								
MIL-M-38780	NON-DESTRUCTIVE TESTING	4/73														
MIL-M-38784A	GENERAL STYLE AND FORMAT REQUIREMENTS	9/75	●	●	●	●	●	●	●	●	●	●	●	●	●	●
MIL-M-38789A	OVERHAUL INSTRUCTIONS AND OVERHAUL INSTRUCTION WITH IPB: VARIOUS EQUIPMENT AND ACCESSORIES	1/73														
MIL-P-38790	GENERAL REQUIREMENTS FOR PRINTING AND PRODUCTION	5/76	●	●	●	●	●	●	●	●	●	●	●	●	●	●
MIL-M-38797	OPERATIONS AND MAINTENANCE INSTRUCTIONS: VARIOUS TYPES OF EQUIPMENT	11/74														
MIL-M-38798B	OPERATION AND MAINTENANCE INSTRUCTION, CIRCUIT DIAGRAMS, ALIGNMENT PROCEDURES AND INSTALLATION PLANNING: CEM EQUIPMENT	12/75														
MIL-M-38799	SCHEMATIC BLOCK DIAGRAMS AND MAINTENANCE DEPENDENCY CHARTS	8/71					○	●								
MIL-M-38800A	ORGANIZATIONAL MAINTENANCE: AIRCRAFT	9/74					●	○								
MIL-M-38807	ILLUSTRATED PARTS BREAKDOWN	11/74							○			●				
MIL-M-38812	MAINTENANCE AND OVERHAUL INSTRUCTIONS (AUTOMOTIVE EQUIPMENT)	4/74														
MIL-M-63010	DOD STANDARD GENERATOR SETS	1/76														
MIL-M-83499	TITLE PAGES AND LIST OF EFFECTIVE PAGES; SAFETY SUMMARY	8/75	●			●						●	●			
MIL-M-83931	FLEXIBLE BINDERS	1/68				●							●			

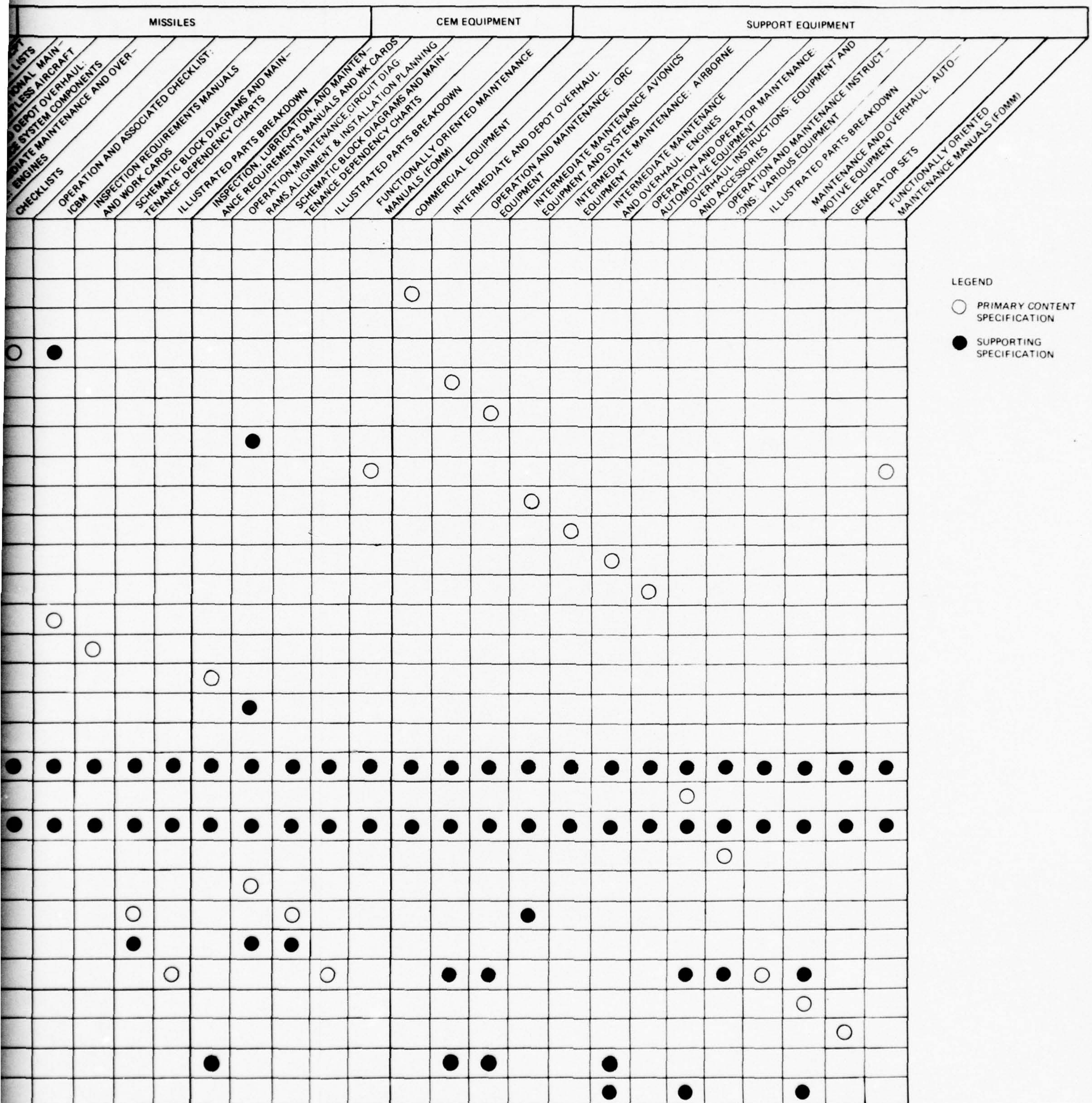

Figure 3-10. Air Force Specification Systems. Air Force TM speciation systems are arranged according to equipment and maintenance types. All documents contained in each column represent the TM specification system for category of TM.

contain no provisions for in-process review, validation and verification. Air Force specification systems provide no requirements for tying the technical manuals to a maintenance study.

Therefore, although the Air Force specification systems will produce manuals that are somewhat job-oriented, and contain some flexibility in presenting data that is unique to different tasks and different equipment types, they lack specific requirements and guidance necessary to produce fully adequate manuals. However, the Air Force and the other services are beginning to realize that they cannot continue to force-fit existing specifications to specific program needs; that existing specifications do not fill the data needs of present equipment technology; and that existing specifications do not fill the data needs of the current equipment user regarding the items of equipment he repairs, and how he actually repairs them. In the past few years, many studies have been completed by the military services on improving technical documentation. Yet, with all the studies, little improvement has surfaced in technical manuals and specifications providing for the development of these manuals.

	SPECIFICATION SYSTEM / MANUAL REQUIREMENT	INSP AND MAINT REQTS CHECK FLIGHT CHECKLISTS: ACFT, MSLS					STRL REPAIR: AIRCRAFT			INTMD MAINT AND OVHL OF ENGS ACFT, MSLS, AUTOMN					ORGANIZATIONAL MAINT (JOB GUIDES): AIRCRAFT, MISSILES						ASSY SERVICING AND ORG MAINT: MSLS			INTMD AND DEPOT OVHL: MSLS AND SPACE SYSTEM						OPERAT… AND CHECKL… ICBM		
		MIL-M-5096D	MIL-M-38784A	MIL-P-38790	MIL-M-83499	MIL-M-83931	MIL-M-9854B	MIL-M-38784A	MIL-P-38790	MIL-M-25394A	MIL-M-38784A	MIL-P-38790	MIL-M-83499	MIL-M-83931	MIL-C-9927A	MIL-C-38778A	MIL-M-38784A	MIL-P-38790	MIL-M-38799	MIL-M-38800A	MIL-M-5166C	MIL-M-38784A	MIL-P-38790	MIL-M-9198A	MIL-M-38784A	MIL-P-38790	MIL-M-38807	MIL-M-83499	MIL-M-83931	MIL-C-9883B	MIL-M-38311A	MIL-M-38784A
STYLE AND FORMAT	GENERAL REQUIREMENTS	2	2					2		2	2						2			2	2	2		2	2						2	2
	TYPOGRAPHY		3					3			3						3					3			3							3
	PRINTING			3		3			3			3		3				3					3			3			3			
	LITHOGRAPHIC NEGATIVES			3					3			3						3					3			3						
	MANUAL/PAGE SIZE	3	3					3			3									3					3							3
	MANUAL DIVISIONS	3	2				3	2		3	2						2			3	3	2		3	2						3	2
	NUMBERING	3	2					2			2						2					2			2							2
	APPENDIXES		3				A				3						3					3			3							3
	INDEX		2					2			2						2					2			2							2
	REFERENCES		2					2			2						2					2			2						3	2
	ILLUSTRATION REQUIREMENTS	1	2					2			2						2					2			2							2
	CHANGES/REVISIONS	1	3					3			3						3					3			3							3
	SUPPLEMENTS		2					2			2						2					2			2							2
	MICROFORM COMPATABILITY																															
CONTENT	FRONT MATTER	3	3		3		3	3			3		3				3					3			3			3				3
	BOOKPLAN (OUTLINE)		C					C			C											C			C							C
	MAINTENANCE PLAN	2																														
	DATA CONTENT	3					2			2	2				3	3			A	3	2			2						3	2	
	PARTS LIST																										3					
	ILLUSTRATION/DIAGRAM USE	3					3			2										3	2			2							A	
	SAMPLE TEXT	3																		1												
	SAMPLE TABLES	3																		1												
	SAMPLE ILLUSTRATIONS	3																		1												
	PREPARATION GUIDE	2																														
READABILITY/ COMPREHENSIBILITY	JOB RELEVENCY						2			2										3				2						2		
	INFORMATION COMPRESSION																			2										2		
	LEVEL OF WRITING	1	1				1	1		1	1						1			2	1	1		1	1						1	[illegible]
	STYLE OF WRITING	2	2				1	2		1	2						2			3		2			2						1	[illegible]
	READABILITY REQUIREMENTS																															
	VOCABULARY GUIDE																			3												
QUALITY ASSURANCE	QUALITY PROGRAM		2					2			2						3					2			2						B	[illegible]
	IN-PROCESS REVIEW																															
	VALIDATION/VERIFICATION																															
	VALIDATION OF READABILITY																															
	APPROVAL AND ACCEPTANCE		1					1			1						1					1			1							[illegible]
	PREPARATION FOR DELIVERY		3	3				3	3		3	3					3	3				3	3		3	3						[illegible]

CING RG MSLS		INTMD AND DEPOT OVHL: MSLS AND SPACE SYSTEM						OPERATION AND CHECKLISTS: ICBM				INSPECTION REQUIREMENTS: MISSILES				INSPECTION, LUBRICATION AND MAINT: CEM EQUIPMENT					OPN, MAINT, CKT DIAGRAMS ALIGN, INSTL: CEM EQPT					FOMM MANUALS: CEM AND SUPPORT			OPERATION AND MAINTENANCE: QRC EQUIPMENT						INTMD MAINT: AVIONICS EQPT				INTMD MAINT: AIRBORNE EQPT			OPN AND OP, MAINT: AUTOMN			OV EQ AC
[illegible]	MIL-P-38790	MIL-M-9198A	MIL-M-38784A	MIL-P-38790	MIL-M-38807	MIL-M-83499	MIL-M-83931	MIL-C-9883B	MIL-M-38311A	MIL-M-38784A	MIL-P-38790	MIL-M-38701	MIL-M-38784A	MIL-P-38790	MIL-M-83931	MIL-M-38777A	MIL-M-38784A	MIL-P-38790	MIL-M-83499	MIL-M-83931	MIL-C-9927A	MIL-C-38778A	MIL-M-38784A	MIL-P-38790	MIL-M-38798B	MIL-M-24100B	MIL-M-38784A	MIL-P-38790	MIL-M-9910A	MIL-M-38784A	MIL-P-38790	MIL-M-38807	MIL-M-83499	MIL-M-83931	MIL-M-25095A	MIL-M-38784A	MIL-P-38790	MIL-M-38799	MIL-M-25393A	MIL-M-38784A	MIL-P-38790	MIL-M-26788C	MIL-M-38784A	MIL-P-38790	MIL-M-38784A
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Figure 3-11. Survey
representative Air
of each system in pr

...N AND MAINT – QRC EQUIPMENT				INTMD MAINT: AVIONICS EQPT				INTMD MAINT: AIRBORNE EQPT			OPN AND OP, MAINT: AUTOMN			OVHL: EQPT AND ACCESSORIES				OPN AND MAINT: VARIOUS EQPT				MAINT AND OVERHAUL: AUTOMOTIVE			
MIL–P–38790	MIL–M–38807	MIL–M–83499	MIL–M–83931	MIL–M–25095A	MIL–M–38784A	MIL–P–38790	MIL–M–38799	MIL–M–25393A	MIL–M–38784A	MIL–P–38790	MIL–M–26788C	MIL–M–38784A	MIL–P–38790	MIL–M–38784A	MIL–M–38789A	MIL–P–38790	MIL–M–38807	MIL–M–38784A	MIL–P–38790	MIL–M–38797	MIL–M–38807	MIL–M–38784A	MIL–P–38790	MIL–M–38807	MIL–M–38812
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LEGEND

1 VAGUE, INADEQUATE, OR CONFUSING

2 ADEQUATE BUT SUBJECT TO INTERPRETATION

3 EXPLICIT

A AS DIRECTED BY PROCURING AGENCY

B AS STATED IN CONTRACT

C IF REQUIRED BY PROCURING AGENCY

Figure 3-11. Survey of Air Force Specification Systems. An evaluation of representative Air Force TM specification systems showing the effectiveness of each system in providing Air Force TM requirements.

3

3.2.1.7 SIMILARITIES AND DIFFERENCES BETWEEN NAVY, ARMY, AND AIR FORCE SPECIFICATION SYSTEMS AND ACQUISITION POLICIES/PROCEDURES

Many commonalities and differences exist among the DoD military components in the specifications systems used for TM acquisition, and in the policies and procedures by which they are acquired. The differences may, in some instances, account for many of the present problems in acquiring, producing, and maintaining military TMs.

Similarities and Differences Between Military Specification Systems - Guidelines for the preparation of TMs are normally furnished to contractors in the form of one or more specifications, invoked as part of the acquisition package for new equipments, systems, or weapons. The specifications used vary among the military services, and vary again between branches of the same service. Moreover, individual specifications frequently refer to (and incorporate by reference) numerous other specifications dealing with such aspects as drawings, microform, format requirements, printing guidelines, job performance aids, maintenance techniques, and quality assurance. The TM writer within the various contractors used by the military must therefore accommodate a wide family of TM specification systems used by the services.

Navy, Army, and Air Force specification systems were described in previous topics of this section. These specification systems were described in terms of the family of documents used to procure TMs for commodity types, and maintenance systems. As shown in these surveys, there are a vast number of specifications used in these specification systems, and a number of systems used among DoD military components. The major areas in which the DoD component specification systems differ are (1) specification system structure, (2) applicability to commodity types, (3) applicability to user needs, (4) response to environmental considerations, (5) content requirements, (6) readability and comprehensibility, and (7) quality assurance provisions. The responses of the various specification systems to the TM critical elements against which they were evaluated are shown in Table 3-XV. This tabulation shows the similarities and differences between the Navy, Army, and Air Force specification systems in meeting the TM requirements.

The averages computed in Table 3-XVI were derived from data contained in Figures 3-7, 3-9, and 3-11. The effectiveness figures (1 , 2 , 3) in these tables were given weighting factors of 30, 60, and 90, respectively. Averages were then computed horizontally, specification system by specification system. These averages were then summed and divided by the number of specification systems in the same to obtain the figures in Table 3-XVI. For example on Figure 3-9 the average percent effectivity of specification systems response for SAMPLE ILLUSTRATIONS was computed as follows:

$$45 + 60 + 60 + 68 + 75 + 70 + 60 + 75 + 60 + 60 + 80 + 45 + 60 + 45 + 90 = 953$$

This number was then divided by 15 (the number of specification systems contained in the Army sample) which results in an average percent effectivity of Army Specification Systems response to this specification requirement of 63.5.

All figures were rounded off to the nearest whole number. Therefore, the average percent effectivity of specification systems response =

$$\frac{\sum_{1}^{N} \frac{①.30}{i} + \frac{②.60}{i} + \frac{③.90}{i}}{N}$$

where N = number of specification systems in sample and i = number of specifications in a specification system that may stipulate a requirement.

Further Observations on Military Specification Systems - Specification-furnished guidance to TM writers, relating to TM usage for training, varies. It extends, for example, from that for electrical, electronic and mechanical equipment or system manuals specified by MIL-M-15071G, in which levels of writing are established for separate sections of the manual, to the family of specification systems used by the Army which cover the development of all types of maintenance information for all Army repair levels in one specification system. In most cases, existing TM specification systems neglect training implications, and provide only general guidance for the content of various TMs. In the past, it has been assumed that what is suitable for the needs of operating and maintenance technicians in the field is sufficient for the needs of the instructors and students in the classroom. In the absence of specific training related guidelines, the suitability of an initial TM draft for use in training depends largely on the judgment and writing ability of the TM writer. This leads to additional costs to develop training materials to supplement the TMs in instructional programs.

Specifications used by the military to procure TM documentation do not make allowances for a wide range of hardware-related subject matter. Because of this, the depth of coverage required for adequate reader understanding of his system or equipment may be lacking. For example, functional descriptions of hydraulic or electronic systems frequently require treatment at different levels of detail to provide complete reader understanding. If the TM writer is expected to produce a TM to a particular level of detail, he must understand what the detail is, and that detail must be clearly specified. This understanding is closely related to the maintenance concept of the system/equipment which most specifications do not adequately address.

New technologies in documentation by the military services are requiring task analysis in writer preparation of TM material. This task analysis requires development of material which defines the user's knowledge and skill requirements for anticipated functions. Because of intense hardware orientation and the amount of detail required, this concept cannot be incorporated effectively into a single specification, to be invoked subsequently for future TM acquisitions. Ideally, a separate specification document should be prepared and furnished to the TM writer for each new system/equipment for which a new TM is to be developed.

3.2.1.7 SIMILARITIES AND DIFFERENCES BETWEEN NAVY, ARMY, AND AIR FORCE SPECIFICATION SYSTEMS AND ACQUISITION POLICIES/PROCEDURES (Continued)

The process by which TM specifications are reviewed, updated and changed by the military services is a lengthy endeavor. Before TMs reach the user employing new techniques in specifications, several years may have elapsed. For this reason, the majority of existing TM specifications are not based on current physical or psychological knowledge. Again, each military service is independently developing new specifications. The overall effort is costly to the military with such duplication. Knowledge and lessons learned by one service are not used advantageously by another.

Similarities and Differences Between Military TM Acquisition Policies/Procedures - The major functional process in the acquisition of TMs by the Navy, Army and Air Force are basically the same. Requirements determination, contract processes, reviews, validation and verification are some of the major functional processes which are performed by each military service. There are, of course, differences in how each service actually performs these functional processes. In the initial identification of TM requirements, all three services are similar to some degree, establishing and working within an integrated logistic environment to some extent. In the planning process, all services require some preparing activity inputs such as TM plans, outlines, schedules, book plans or additional TM requirements. Review, update and modification of these, as well as reviewing TM development is a similar function among the services. All services require validation, and perform verification with user command personnel or provide for combined validation and verification. For the acceptance function, all three services sometimes utilize Defense Contract Administration Service (DCAS) to ensure contractual compliance, but the Air Force also uses its AFPRO (Plant Representative Office) with final acceptance by the using command.

All three services tailor their TM acquisition activities to the magnitude of the system/equipment for which the TMs are being procured. For a major weapon system procurement, the Army establishes a Program Office, with the Program Manager generally coming from within the cognizant Commodity Command. The Air Force establishes a Special Project Office with the Manager generally coming from the "service" (or commodity type) command. The Navy establishes Program Management Offices with the Program Managers generally coming from a recent "user" command assignment. For these procurements, the services generally utilize a "team" approach, with team members representing all the necessary disciplines. Lesser procurements in terms of TM acquisition support may range from scaled down "teams" to an individual assigned TM responsibilities.

The Navy, Army and Air Force are all subject to the guidelines of DODINST 4151.9 on matters of TM management. Much of this responsibility is passed through the service command structure before an adequate grasp on the situation is obtained at the higher level of command. Subsequent delegations to implementing activities, while the reins are still loose, results in the diversity that is presently experienced in the services today.

TABLE 3-XVI. COMPARISON OF MILITARY SPECIFICATION SYSTEMS

Specification Requirements		Average Percent Effectivity of Specification Systems Response		
		Navy	Army	Air Force
Style and Format	General	58	60	62
	Typography	83	90	90
	Printing	48	NA	90
	Lithographic Negatives	48	NA	90
	Manual/Page Size	76	84	80
	Manual Divisions	56	56	74
	Numbering	49	61	61
	Appendixes	27	89	80
	Index	53	61	57
	References	55	62	58
	Illustrations	66	61	59
	Changes/Revisions	48	90	87
	Supplements	3C	56	59
	Microform Compatibility	42	0	5
Content	Front Matter	69	90	90
	Book Plan (Outline)	23	84	2
	Maintenance Plan	23	0	5
	Data Content	60	54	61
	Parts List	60	66	15
	Illustration/Diagram Use	65	45	52
	Sample Text	30	12	20
	Sample Tables	55	64	23
	Sample Illustrations	67	64	25
	Preparation Guide	12	8	7
Readability	Job Relevancy	18	4	45
	Information Compression	25	4	18
	Level of Writing	40	34	33
	Style of Writing	48	56	57
	Readability	0	90	0
	Vocabulary Guide	28	6	5
Quality Assurance	Quality Program	78	36	63
	In-Process Review	62	30	5
	Validation/Verification	80	84	12
	Validation of Readability	0	90	0
	Approval and Acceptance	64	18	35
	Preparation for Delivery	69	90	90
Percent Response to All Requirements		48	50	45
Percent Response to Requirements Contained in Specification		50	56	47

NOTE: The percentages shown in this table were derived by taking weighted averages of data developed for each specification system in topics 3.2.1.4, 3.2.1.5, and 3.2.1.6.

3.2.1.7 SIMILARITIES AND DIFFERENCES BETWEEN NAVY, ARMY, AND AIR FORCE SPECIFICATION SYSTEMS AND ACQUISITION POLICIES/PROCEDURES (Continued)

In the TM acquisition processes, there are degrees of difference in the involvement by the three services at the upper command level (DARCOM, NAVMAT and AFSC/AFLC). Both the Army and Air Force, at this level, provide a set of coordinated, detailed implementing directives to their subordinate commands which results in more uniform and centralized control of the TM acquisition process. On the other hand, NAVMAT relies on the SYSCOMs to issue and promulgate their own directives and delegates to the SYSCOMs these responsibilities. This is the major difference between the Navy and the other services - less centralized control and direction of the TM acquisition processes at the upper command level.

In the Navy, the results are that NAVAIR, NAVSEA, and NAVELEX develop their own TM acquisition policies and procedures. NAVAIR presently has seven major policy and procedures instructions[1] defining TM processes, and several guidance documents[2]. NAVSEA has recently published two major policy and procedures instructions[3], and is in the process of developing implementation guides. NAVELEX has one major policy and procedures instruction[4], and sometimes makes use of those developed by NAVAIR. In the development of these policies and procedures by the Navy SYSCOMs, there is little or no coordination or joint usage of these instructions. In the Air Force and Army, policies and procedures are coordinated and changed at a level above the user commands. This results in joint directives which are applicable to all Army or Air Force activities involved in the TM acquisition process.

Lack of control at the upper command level also leads to other diversities within the services. Uncoordinated research and development in new TM technologies and TM specification development are two major problems. Central control of these two activities is essential if duplicate efforts are to be eliminated and joint implementation into the service, to bring about some standardization, is to be achieved.

In addition to developing their own TM acquisition policies and procedures, each Navy SYSCOM goes its separate way in the development of new TM technologies. Separate efforts by NAVAIR and NAVSEA in areas of microforms, presentation methods, readability and comprehension, and TM specification development are a few examples. In the past, these areas were also more fragmented in the Army and Air Force but more coordinated efforts have been enacted in the past few years. The Army is probably the best example of this coordination. New TM technologies in the Army, including specification development, are coordinated by the Technical Manuals Branch within the USAMMC arm of DARCOM. While projects fall under the cognizance of the Commodity Commands, results are applicable to other Army Commodity Commands. One of the biggest advantages of this coordinated effort is the speed with which improvements are made, incorporated in TM specifications, and brought into application with new manual development.

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[1]See list at end of topic.
[2]See list at end of topic.
[3]See list at end of topic.
[4]See list at end of topic.

[1]NAVAIRINST 5600.5A, "System for Preparation and Promulgation of Interim Changes to NATOPS Flight Manuals," 9 July 1976

NAVAIRINST 5600.7A, "Aeronautical Technical Manual Requirement Codes; Instructions Concerning Determination, Assignment and Approval Of," 6 February 1976

NAVAIRINST 5600.9A, "Policies and Responsibilities for Management and Coordination of Technical Manual In-Process Reviews, Validation and Verification," 19 October 1973

NAVAIRINST 5600.16A, "Technical Manual Program, Procedures and Responsibilities for the Planned Maintenance System Technical Documentation," 29 August 1974

NAVAIRINST 5600.19A, "Policy, Procedures and Responsibilities for Technical Manual Rapid Action Change Program," 5 January 1976

NAVAIRINST 5600.20A, "Policies and Responsibilities for the Naval Air Systems Command Technical Manual Program," no date

NAVAIRINST 4000.9A, "Management of Technical Data," 30 July 1971

[2]NAVAIR 00-25-100, "*Naval Air Systems Command*, Technical Manual Program," Technical Manual, 1 May 1972

NAVAIR 00-25-600, "In-Process Review, Validation and Verification Guide," Technical Manual, 15 July 1969

NAVAIR 00-25-601, "Management Procedures for Out of Production Category of Aircraft/Equipment Manuals," Management and Procedures Manual, 15 October 1973

NAVAIR 00-25-700, "Technical Manual Preparation Guide for Technical Writers, Editors, and Illustrators," Management and Procedures Manual, Preliminary, 1 June 1976

[3]NAVSEAINST 5600.7, "NAVSEASYSCOM Technical Manual Acquisitions; Policies and Responsibilities For," 21 July 1976

NAVSEAINST 5600.8, "NAVSEASYSCOM Technical Manual Maintenance; Policies, Procedures and Responsibilities," 21 July 1976

[4]NAVELEXINST 5600.7, "Acquisition and Quality Assurance of Technical Manuals for New Equipment/Systems; Requirements For," 18 August 1975

3.2.2.1 PROPOSED IMPROVEMENTS AND TRENDS IN NAVY SPECIFICATIONS

In the past few years, innovations and improvements in Navy TM specifications have remained relatively dormant. Suggestions for improvements have been made, but little action has taken place. Recently, the major changes in Navy TM specifications are due largely to the SYSCOMs commitment to microform. Some recent modifications in format and content arrangements, also microform inspired, and work on readability and comprehensibility specifications, as well as writer guides, do promise some improvements in the use and application of Navy TM specifications.

Recognizing problems in the diversity of methods and procedures employed by the SYSCOMs to manage their TM programs, in 1974 the Chief of Navy Materiel (CNM) convened an ad hoc committee to (1) review existing policies, procedures, and inter- and intra-SYSCOM relationships, (2) determine ways of presenting a single face to the fleet in TM management, and (3) conserve resources both at the fleet and headquarter level. The report[1] of this committee contained an analysis of 15 problem areas with recommendations for improving TMs and their management control, including establishment of a large central TM management organization.

One of the Navy TM problem areas defined in this report was in the area of specifications, standards, and data item descriptions (DIDs). The report acknowledges the proliferation of these items among the SYSCOMs and the myriad of differing TM types, sizes, arrangements, and presentation techniques being supplied to the fleet as a result. It recognizes that these are often not suitable for the environment in which the user operates and maintains the equipment, are an unnecessary burden on him, and compound his training problem.

The report further states that (1) TM management problems are compounded by the proliferation of specifications, (2) inappropriate specifications are available for TM procurement, and (3) it is difficult to maintain specifications current with the state of the art, which leads to a continual development of new specifications.

The committee report made four recommendations for solving Navy TM specification problems: (1) review of existing TM specifications with the view to eliminating and/or consolidating them and extending their application, (2) coordination and approval of new specifications, (3) centralize liaison with other DoD components and industry, and (4) analyze results of documentation research and development to determine requirements for development and coordination of new specifications and standards. It is noteworthy that while the CNM took no action on these specific recommendations, actions[2] taken which further decentralized Navy TM management control made future implementation of these recommendations more difficult and much more necessary.

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[1] NAVMAT Ad-Hoc Committee, "Central Management of Technical Manuals for the Fleet, Report in Response to CNM Action Sheet 61-73," 19 April 1974

[2] CNM Ltr 0422/WJC dated 21 June 1974, "Implementation of Recommendations Resulting From CNM Action Sheet 61-73, Central Management of Technical Manuals for the Fleet"

NAVAIR has been experimenting with the use of microfilm for the past several years. To augment their use of microfilm they developed the Work-Package concept for TMs, and released specifications for Work-Package manuals. The goal of the Work-Package concept was to enhance the usability of manuals through improved format, improved organization, and improved comprehensibility. The Work-Package concept reduces text to essentials, and packages data in task-oriented increments. Along with the new Work-Package specifications, NAVAIR improved contract definition. This combined effort resulted in manuals with microform-compatible format and simplified organization but did not solve the problem of usability. NAVAIR then improved administrative and technical manual preparation. The result was more accurate manuals, but still not usability. Further research indicated that two distinctly different technical manuals could be expected when procured from two different sources, even though both sources used the same specifications. Therefore, better specifications did not solve the problem of producing uniform manuals. NAVAIR researchers then concluded that specifications define what a manual should look like after it is completed, but contain no guidelines for the technical writers on how to write manuals to meet the requirements of the specifications. NAVAIR then developed and released a preliminary guide, NAVAIR 00-25-700, Technical Manual Preparation Guide for Technical Writers, Editors, and Illustrators. This document addresses itself to those who prepare technical manuals and provides guidance in preparing Work-Package manuals. This is the first document that addresses the content of the manuals rather than the format. It contains guidelines on how to determine what should go into the manuals, and on how to make the text and the illustrations comprehensible. Some of the provisions of this document are applicable to other types of manuals but it is basically Work-Package oriented.

In a separate effort, NAVSEA developed a rough-draft specification[1] for technical manual readability and comprehension requirements. This specification sets forth guidelines for simplifying NAVSEA manuals and for making the text and illustrations more comprehensible. The specification provides methods for measuring the readability and comprehensibility of both text and illustrations. The measurement techniques in this specification are similar to those given in NAVAIR 00-25-700 but differ in some points. The readability measurement criteria in NAVAIR 00-25-700 and NAVSEA specification contain measurements for both text and illustrations. The NAVSEA readability specification contains a preferred verb list. The basic style and format specification for NAVAIR Work-Package manuals (MIL-M-81927) also contains a preferred verb list. These two verb lists generally contain the same verbs; however, the NAVSEA list contains many more verbs than the NAVAIR list. The NAVAIR list contains some verbs that the NAVSEA list does not contain.

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[1]NAVSEA MIL- -   (OS), "Manuals, Technical: Improved Comprehension Requirements," Draft Military Specification, 11 October 1976

3.2.2.1 PROPOSED IMPROVEMENTS AND TRENDS IN NAVY SPECIFICATIONS (Continued)

The NAVSEA readability specification is intended to be used with one of the NAVSEA primary content specifications for TM procurement. The primary content specification takes precedence over the provisions of the readability specification. However, the readability specification contains provisions for manual organization and methods of presentation that differ from the provisions contained in NAVSEA primary content specifications. Therefore, to make the provisions of the readability specification effective, the provisions must be cited in the contract. This adds to the burden of the procuring agency in setting forth the manual requirements, and the contractors in interpreting them.

A draft copy of NAVSEA and NAVELEX conventional manual specification MIL-M-15071H was released for review and comment in early 1975. This specification revision is intended to supersede the 'G' revision. In the 'H' revision, the scope was revised to include three levels of maintenance: organizational, intermediate, and depot. A scope-of-coverage paragraph was added, indicating that all three levels of maintenance are to be included in the same manual unless the contract requires that the information be included in a separate document. However, the content requirements of the specification do not make any provisions for different types of coverage for different levels of maintenance, nor do they give any guidance in determining what the different levels of maintenance are. Any division into different maintenance levels must come from some external source. In the content requirements for maintenance data, the only mention made of any separation of maintenance data is in the troubleshooting provisions. In the troubleshooting provisions there is no distinction made between the different levels of troubleshooting except that they shall be placed in different paragraphs.

Specification MIL-M-15071G provides requirements for three general types of TMs - Types I, II, and III. Not all of the requirements in the specification are applicable to all types of TMs. The distinction provided between the data for the different TM types is made in MIL-M-15071G by a parenthetical entry in the paragraph headings. In MIL-M-15071H, the determination of the requirements for the different TM types was improved by tabulating their requirements. Additional requirements were added for data to be submitted with the book plan. These requirements are a milestone schedule, a validation plan, and a preliminary list of test equipment to be used. In addition, validation requirements include a certification that all necessary data is included in the TM.

These changes in MIL-M-15071 tighten some of the quality assurance provisions and make the specification a little easier to use; however, they do nothing toward improving the readability and comprehensibility of TMs, toward making TMs more job-oriented, or toward making the data in TMs more accessible.

NAVSEA, NAVELEX, and NAVAIR are using, or in the process of implementing, microforms for their TMs. NAVSEA and NAVELEX are presently converting to microfiche and NAVAIR has implemented the MIARS (Maintenance Information Automated Retrieval System) and TRUMP (Technical Review and Update of Manuals and Publication) projects. The MIARS Project is the NAVAIR program to convert and integrate into the fleet all their microfilm products, as well as to provide readers and reader/printers. It also integrates the output of TRUMP. The TRUMP system is the microform conversion process of NAVAIR out-of-production TMs. These TMs are optically scanned, digitally stored, updated on-line or through peripheral equipment, and computer-output as 16mm microfilm.

Most of the past, proposed, and implemented improvements in Navy TM specifications have mostly impacted TM format. This has, by necessity, been required because of the SYSCOMs commitment to microform products. However, with the release of NAVAIR 00-25-700 and the proposed NAVSEA specification for readability and comprehension, the trend will be moving toward improved TM content.

Meanwhile, the SYSCOMs continue to go their separate ways, producing new specifications and updating old specifications in an attempt to solve their individual TM problems. The independent, uncoordinated issue of new specifications by the SYSCOMs adds to the difficulty in solving Navy TM problems and increases the burden on the TM procuring activities and contractors. As recommended by the NAVMAT ad hoc committee, a centralized grasp on improving TM specifications could result in better and more uniform TMs than are presently presented to the fleet.

3.2.2.2 ARMY AND AIR FORCE SPECIFICATION TRENDS

DoD components have come to realize that reduction in maintenance personnel and training costs, and any improvements in quality and efficiency of the performance of maintenance, will result in reduced life cycle cost of hardware systems. To this end, the Army and Air Force have been developing specifications for manuals which provide step-by-step directions for both troubleshooting and nontroubleshooting tasks.

Future trends in Army and Air Force TM specification systems are toward Fully Proceduralized Job Performance Aids (FPJPA). According to Air Force report AFHRL-TR-76-58[1], the Air Force uses the term Job Guide Manual in referring to maintenance manuals for nontroubleshooting tasks, developed in keeping with FPJPA technology. The Army uses the term Job Performance Manuals for the same case. The Air Force is currently calling its FPJPA for troubleshooting tasks Fully Proceduralized Troubleshooting Aids (FPTA). The following describes recent developments in the Army and Air Force which are influencing trends in their TM specifications.

Army Specification Trends - In the Army, the Training and Doctrine Command (TRADOC) and the Development, Acquisition, and Readiness Command (DARCOM) have a joint program underway to improve maintenance training and the quality of technical manuals. This program is the Improved Technical Documentation and Training (ITDT) Program. The ITDT approach is to perform an equipment analysis, functional analysis and a detailed task analysis prior to and during the development of the TM and training packages. These analyses result in a recommended list of tasks to be covered in the TM, and a list of tasks to be covered by training. A decision is then made as to what goes into the TM and what flows into the training area. The TM is then developed as a Job Performance Manual (JPM) that includes step-by-step instructions, profusely illustrated, aimed at a target population of novice mechanics. The training package could consist of both school courses and extension courses. Present plans call for more emphasis on extension training and less institutional or school training. For the past three years, TRADOC has been developing Training Extension Courses or TEC for on-the-job Army training programs. Under ITDT, the TEC is known as Extension Training Material or ETM.

In the past two years, DARCOM has done extensive work on improving Army manuals both in-house and by contractors. The in-house efforts were logbook size manuals on various Army howitzers. Commercial efforts were in the areas of specification development for operator and organizational manuals. Four contractor projects have been completed, two of which (RCA[2] and Kinton[3]) are being used on ITDT.

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[1] Foley, Jr., John P., "Hard Data Sources Concerning More Cost Effective Maintenance," AF Human Resources Laboratory, AFSC, July 1976

[2] Mathews, C.F., et al, "Study and Proposal for the Improvement of Military Information Transfer Methods," Final Report, RCA, July 1975

[3] Shriver, E.L., et al, "Study and Proposal for the Improvement of Military Technical Information Transfer Methods," Final Report, Kinton, Inc., Dec 1975

The first ITDT specification covering the entire technical documentation and training package was completed in December of 1975. It is based on the Kinton specifications, draft MIL-M-632XX (TM) (Part I) and (Part II). This specification is also planned for use in two Army development projects: the XM-1 tank, and TACFIRE for the battery computer system.

In the area of fielded items, two demonstration projects have been selected. One project is on all existing tank turret systems. This is to include all turrets of the M60 series, M551 and the CEV M728, with associated Military Occupational Specialties (MOS) of 45K, 45N, 45P and 45R. The other project is for wheeled vehicles and the associated 63B MOS. Items to be developed as a result of these demonstration projects are complete ITDT packages, consisting of technical documentation and a training package, as well as refined specifications. Two companies are presently under contract for these projects, Hughes Aircraft Company and Data Communications, Inc.

In the past few years Hughes has been involved in the development of Army operator and organizational specifications. The Hughes-drafted MIL-M-630XX (TM) and Army MIL-M-63047 (TM) has resulted in the recently released Army operator Specification MIL-M-63036 (TM). The Hughes-drafted MIL-M-631XX (TM) has resulted in a draft set containing a specification, handbook, and writer's style guide for the preparation of organizational, direct and general support (DS/GS) Army manuals. These are MIL-M-63038 (TM), -1 (TM), and -2 (TM). respectively. The same Hughes activity is presently involved in the ITDT development of simplified -10 (operator's manual) and -20 (organizational, DS/GS manuals) for the Army tank turret project.

As previously stated, the complete ITDT package will consist of a technical documentation and a training package. The technical documentation will contain all the essentials for a novice mechanic to perform his job in a simplified, illustrated, step-by-step format. The training package will be in the Extension Training Mode (ETM). The ETM can be in one of several media such as audio or audio-visual. One key element of ITDT that differs from the conventional TM system involves a detailed "Front End Analysis." This analysis is very comprehensive, and should produce certain intermediate products such as block diagrams that are eventually included in the manuals. This analysis includes what is already part of the MEADs or LSAR system, but is much more comprehensive. The other main element is the final verification of the ITDT package. This verification is to be performed by the representative personnel of the target population. Besides the existing requirement to determine if the manual is complete and accurate, the verification will determine if the soldiers can use and understand the manuals.

It is very beneficial for the NTIP Program to monitor this and other Army and Air Force projects in keeping current with recent TM developments. It is the very essence of this program, through the development and combination of ideas in the TM community, to improve the operational readiness of Navy equipment. The improvement and development of TM specifications with a closer coordination during development of training and documentation is a necessary step in the right direction.

3.2.2.2 ARMY AND AIR FORCE SPECIFICATION TRENDS (Continued)

Air Force Specification Trends - According to Air Force Report AFHRL-TR-76-58, the current status of the application of FPJPA technology in the Air Force as well as supporting references are found in AFHRL-TR-75-82[1]. The Air Force Human Resources Laboratory (AFHRL) is currently conducting a controlled comparative field evaluation of FPTA, logic tree aids, and technical orders. This study is considering the potential impact of such aids for both the organizational and intermediate levels of maintenance. The PRAM Program Office at Wright-Patterson AFB is also conducting a study concerning the effectiveness of FPJPA for non-TS tasks (Job Guide Manuals) for the organizational maintenance of the C-141 aircraft.

The result of these and other Air Force studies are significant in viewing projected trends in TM specifications for Air Force Technical Orders. Some of the recommendations and conclusions stated in AFHRL-TR-75-82 impacting future trends in Air Force specifications are given below. Both AFHRL-TR-75-82 and AFHRL-TR-76-58 are recommended as primary sources and further references of Air Force research and implementation of FPJPA.

AFHRL-TR-75-82 Recommendations - The official specification for the production of FPJPA for nontroubleshooting tasks and for the production of Maintenance Dependency Charts (MDC), MIL-M-38800, and MIL-M-38799, should be modified to require the production and use of subproducts of task identification and analysis such as are found in AFHRL-TR-73-43 (I)[2]. The specifications for MDC in MIL-M-38799 should reflect the special additional subproducts of analysis for MDC found in MIL-J-83302. FPJA technology should be applied to all nontroubleshooting tasks for both organizational and intermediate maintenance, not just to organizational maintenance for aircraft.

The report further recommends that a careful study should be made concerning the advantages and disadvantages of developing separate specifications for task identification and part of the required analyses of the identified tasks, and deleting these requirements from specifications for FJPA and MDC. Defining that such a division may have advantages for two-step procurements of such data.

The report concludes that the complete implementation of the following categories of data in TM specifications should greatly improve the quality of maintenance on Air Force systems:

- FPJPA for nontroubleshooting tasks
- MDC with pictorial locators
- Keyed schematics
- Keyed information

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[1] Foley, Jr., John P., "A Proposal Modified Technical Order System and Its Impact on Maintenance, Personnel and Training," AF Human Resources Laboratory, AFSC, December 1975

[2] Joyce, Reid P. et al, "Fully Proceduralized Job Performance Aids, Draft Military Specification for Organizational and Intermediate Maintenance," AF Human Resources Laboratory, AFSC, December 1973

- Pictorials with locator grids
- Aircraft wiring diagrams
- Illustrated parts breakdowns
- Preservation, shipping and storage information for any system

This assumes that MIL-M-38800 and MIL-M-38799 are modified to require the necessary task identification and analysis subproducts, and that these subproducts are used properly in the management of the development of FPJPAs for nontroubleshooting tasks and the MDC. In addition, the amount of on-the-job training required before first-enlistment three-level personnel could be assigned to perform nontroubleshooting tasks would be greatly reduced. Finally, the report states that these maintenance and training gains would result in a substantial reduction in life cycle costs for a system.

Another significant and appreciable conclusion was that for effective implementation of the Technical Order and job-oriented training proposals of this report, high-level, positive, aggressive action supported by the necessary funds would be required, as implementation would require the changes of attitudes and behaviors of too many people to come about just because the proposals are sound.

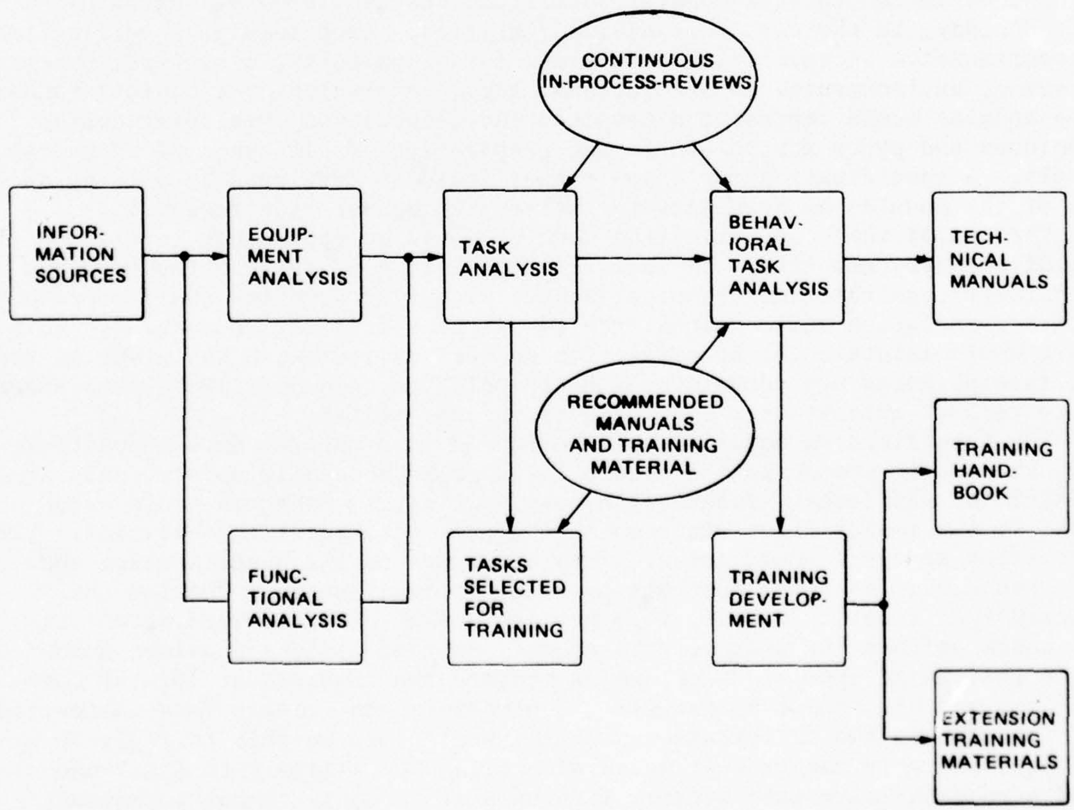

Figure 3-12. ITDT Relationship of Training to Technical Manual Development. The ITDT concept calls for a new approach of complete interface between technical documentation and training.

3.2.2.3 CONCEPT OF MODULAR SPECIFICATIONS

The size of DoD military components, and the vast quantity of equipments for which documentation is required, supports the concept of centralization of the profusion of military specifications which apply to the generation of technical data. The need is present and the technology exists to handle automated filing, update, and retrieval of modular specifications.

The design and preparation of technical manuals to support a piece of equipment invokes the requirements of a primary specification and a chain of other applicable specifications and documents. Many of the applicable specifications and documents cited by the primary specification, in turn, cite other specifications or documents, resulting in a chain reaction. Control of this chain reaction is attempted by procuring agencies, to some degree, with a Technical Manual Contract Requirement (TMCR) document. This document which becomes part of the contract, takes exception to some parts of invoked specifications and will, in many cases, invoke additional requirements. This is the biggest problem with current specifications used to design technical manuals. They do not adequately define what is required in a straightforward manner.

The basic concept for modular specifications as viewed by Hughes Aircraft Company, is the use of standalone entities. Each modular specification is comprehensive in specifying provisions for a commodity, user type, processes, packaging, environmental considerations, etc., in developing technical manuals. These modules would represent a complete encyclopedia on developing content, techniques and processes to use in the preparation of all types of technical manuals. A specification for a new manual would be developed by picking as many of the modules as necessary to satisfy the manual requirements.

The use of these specification modules would be applicable to all Department of Defense components. A committee consisting of representatives from all primary cognizant DoD technical manual procuring agencies could provide for the formulation and continual review of the specification modules. This review would maintain the specification modules current with the state of the art, incorporating new techniques and technologies, and most important, updating to reflect current user requirements in the military.

The specification modules would be stored in a central data repository. Here, the master specification module files could be easily updated and accessed for retrieval. Technical manual acquisition managers would have access to the master files via remote terminals with print capabilities. The acquisition managers would select, from the index to the specification modules, those modules which meet his particular requirements. Putting the selected specification modules together, he designs a customized specification which defines his precise data needs. He then assigns a unique number to the customized specification, which becomes the requirement for the CDRL line item for his technical manuals. Contractors who receive this customized specification in the solicitation package, would then be able to reply in a more knowledgeable manner. It would also allow the military to track and build a comprehensive cost history file on what it costs to buy technical manuals with each specification module, and various combinations of them.

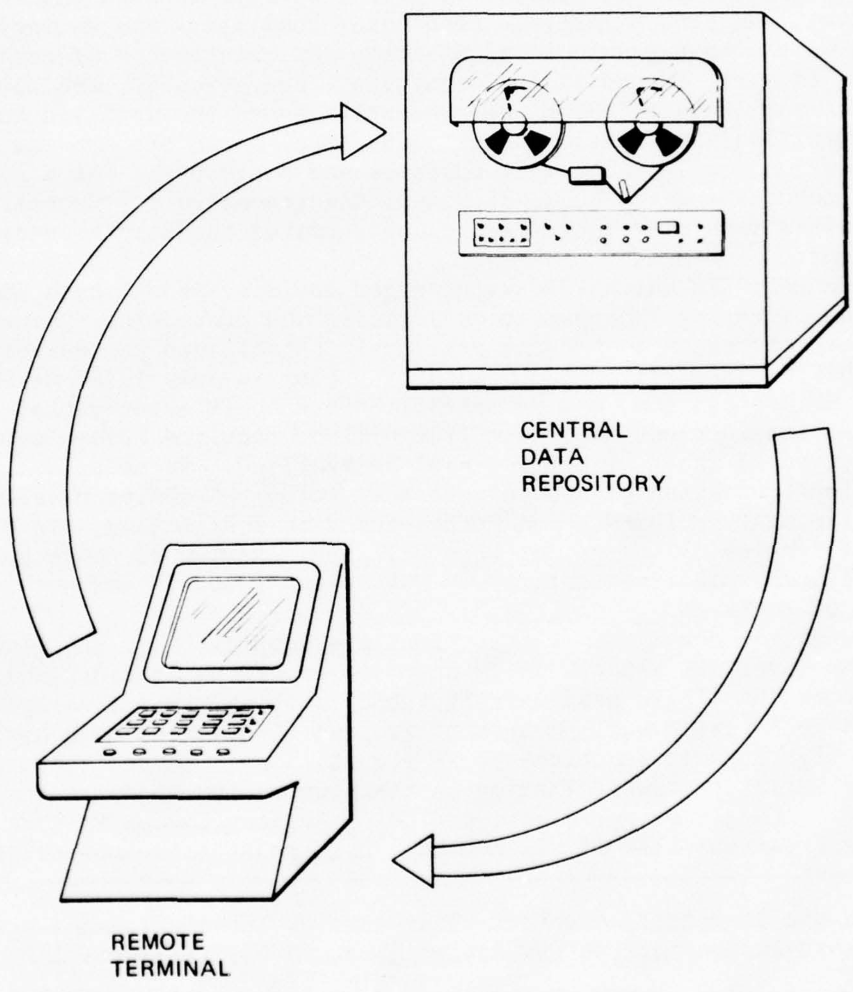

Figure 3-13. Automated Storage and Retrieval of Modular Specifications. The acquisition manager selects and tells the Central Data Repository which modules he wants for his TM specification. The Central Data Repository formats the information and feeds it to the remote terminal at the acquisition activity.

3.2.2.4 PROPOSED NAVY TM ACQUISITION POLICIES AND PROCEDURES

Improvements to TM acquisition management within the Navy currently consist of updating, issuing, and implementing directives relating to policies, procedures, and responsibilities. Additionally, recommendations[1] have been made to centralize technical manual management at the NAVMAT level.

Navy recognition of the need for improvements in its TM acquisition policies and procedures is evident in recent efforts enacted and being enacted at the NAVMAT and SYSCOM levels. Fleet user complaints and an increasing awareness of the cost growth in acquisition and maintenance of technical manuals have, in part, forced this recognition. Specifically, the Naval Sea Systems Command (NAVSEA SYSCOM) has recently issued two detailed instructions[2] on TM acquisition and TM maintenance, and NAVMAT is in the process of updating its instruction[3] on TM management policies and procedures. At a recent meeting[4] in October the Navy Technical Manual Management Policy Council pointed up specific areas requiring improvements and stressed the single centralized support concept.

Before NAVSHIPS and NAVORD were merged to form NAVSEA, each implemented its own and differing TM acquisition policies and procedures. Since the merger, both continued to use the previously established procedures. To rectify this, NAVSEA issued two new instructions in July 1976, NAVSEAINST 5600.7 on TM acquisition, and NAVSEAINST 5600.8 on TM maintenance. These are complex instructions, and some time will be required before even partial implementation of their objectives will be realized. In an effort to assist in their implementation by subordinate activities, NAVSEA is presently developing preliminary implementation guides for each instruction. In October of 1976, draft copies of the guides were released. Review of these guides indicates that much work remains to truly make them "guides," and not just encyclopedias of terms.

Although the new NAVSEA instructions are complex, they are also comprehensive and cover all aspects of TM acquisition. Both instructions assign NAVSEA 046 as the single headquarters agency responsible for management of the NAVSEA Technical Manual Management Program (TMMP), and both assign to NSDSA specific support functions in TM acquisitions. These instructions attempt to maximize standardization in the procurement of new manuals as well as permanent changes or revisions, excluding Advance Change Notices (ACNs) which have a maximum life of six months. Both require the use or performance

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[1] NAVMAT Ad-Hoc Committee, "Central Management of Technical Manuals for the Fleet Report in Response to CNM Action Sheet 61-73," 19 April 1974

[2] NAVSEAINST 5600.7, "NAVSYSCOM Technical Manual Acquisition; Policies and Responsibilities," 21 July 1976
NAVSEAINST 5600.8, "NAVSYSCOM Technical Manual Maintenance; Policies, Procedures and Responsibilities," 21 July 1976

[3] NAVMATINST 5600.10, "Technical Manual Management; Policies and Procedures," 28 February 1968

[4] CNM ltr 0422/WOH dated 20 October 1976, "Technical Manual Management Policy Council"

of TMCR/TMSR, CDRL, reviews, validations, verifications, and two phases of acceptance.

NAVSEAINST 5600.7 is addressed to the acquisition of TMs for new ship systems and equipment, as opposed to the maintenance of existing TMs. It provides for the systematic development of TM requirements from initial conception of the new ship system through continual refinement to finalization of the ultimate requirements. It also provides the procedures for delayed ordering when the final TM requirements cannot be defined until completion of the design effort. After finalization of requirements, the major functional activities in the TM acquisition process become standardized, with minor exceptions to those required by NAVSEAINST 5600.8.

NAVSEAINST 5600.8 is addressed to ACNs and permanent changes, or revisions incident to and not incident to hardware changes. It establishes the procedures and responsibilities for providing a system which is responsive to TM deficiencies and problems reported by users. Each SHIPALT, ORDALT, Field Change or other proposed change must be analyzed to determine the extent of associated TM changes, impacts on other TM, and whether or not the change should be handled as an ACN, permanent change or revision. For permanent changes and revisions, NSDSA notifies the cognizant technical activity (CTA) of all outstanding ACNs and deficiencies that should be consolidated during the update. NSDSA also conducts analysis and review of proposed changes/revisions as well as tracking the conversion of ACNs to permanent changes or revisions.

Advance Change Notices (ACNs), issued to correct a deficiency or problem classified as EMERGENCY or URGENT, do not follow the functional procedures used in the acquisition of new TM or permanent changes or revisions. They are originated by any CTA in response to a need identified by a user or as a result of changes/revisions incident to or not incident to hardware changes. NSDSA controls, assigns, records, and tracks ACN numbers. The CTA approves and determines distribution of ACNs which are issued in message or letter format. The brief ACN issuance procedure provides a rapid method of getting required changes to TM holders.

Subsequent to the finalization of TM requirements per NAVSEAINST 5600.7 and the required analyses per NAVSEAINST 5600.8, the major TM acquisition functions become somewhat similar. That is, the TMCR/TMSR and CDRL are prepared, contract or amendment is issued, identification numbers are assigned, conferences and in-process reviews are conducted, validations and verifications performed, etc. This uniformity of functional procedures will eliminate guesswork and delays in the acquisition process once the pattern is established by the acquiring activities.

3.2.2.4 PROPOSED NAVY TM ACQUISITION POLICIES AND PROCEDURES (Continued)

At the NAVMAT level, an updated version of NAVMATINST 5600.10 is currently being processed through the SYSCOMs for impact statements and comments. Its predecessor, dated 28 February 1968 and entitled "Technical Manual Management; Policies and Procedures," established the Technical Manual Management Policy Council (TMMPC). It was addressed specifically to System Command Headquarters and CNM designated Project Management Offices, and centralized only policy responsibility under MAT 04. Content of the updated version is unknown, except that it implements OPNAVINST 4410.1A[1] which, among other provisions, directs the automation of TM inputs, recognizes human factors engineering requirements in TM, directs CNM administration of the Technical Manual Improvement Program (TMIP) and directs CNET, BUMED and BUPERS collaboration in TMIP and participation in TMMPC. It is apparent that these provisions, if implemented in the updated version of NAVMATINST 5600.10, will have an impact on the SYSCOM acquisition processes.

Additionally, in 1974, a NAVMAT ad hoc committee[2] in response to a CNM Action Sheet recommended centralized management of technical manuals by establishment of a "Navy Technical Manual Management Organization (NTMMO)" at the NAVMAT level. It further recommended improvements in 15 functional elements of TM management as they apply to the NTMMO. This concept of centralized management has long been recognized and extolled, both from a standardization and cost-effectiveness viewpoint. As late as October 1976, at a meeting of the Navy Technical Manual Management Policy Council, it was again recommended by NAVAIR that a fully staffed TM group be established at the NAVMAT level with authority over policy, specification approval, and fund allocations. Advantages cited by NAVAIR included lower costs, elimination of duplicate efforts and expenditures among the SYSCOMs, and providing the Fleet with a single medium.

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[1] OPNAVINST 4410.1A, "Navy Technical Manual (TM) Management; Policies and Responsibilities For," 17 April 1975

[2] NAVMAT Ad-Hoc Committee, "Central Management of Technical Manuals for the Fleet, Report in Response to CNM Action Sheet 61-73," 19 April 1974

SUBSECTION 3.3
RESEARCH ISSUE 3: CONTENT GENERATION

3.3.0 DEFINITION AND OBJECTIVES OF CONTENT GENERATION

The content generation function is extremely critical in any technical manual system in that it represents the most significant and the final point of impact on Maintenance and Operating Technical Data (MOTD) quality. An ineffective content generating activity will misinterpret or circumvent the stated intention of the data acquisition rules and develop low quality MOTD which is then captured, replicated, and distributed to the user in this form.

Content Generation Definition - The content generating activity is normally a contractor; however, it may also be the military agency in-house capability. From the contractor's standpoint, the process of developing MOTD content is essentially the same whether dealing with the three Navy System Commands, the Army, or the Air Force. This function is responsible for collecting the data, preparing technical publications planning documents, writing the TM, critiquing the TM and performing validation. Guided by the data acquisition rules, the content generator performs the human transformation of the engineering/manufacturing/maintenance data bases into MOTD. As a result of human involvement, the transformation output is subject to interpretations, biases, inadequacies, and errors. The quantity and quality of the output is both time and dollar constrained.

The most critical inputs to the content generation function are the engineering/manufacturing/maintenance data bases and the data acquisition rules which should provide guidelines for performing the user-data match and head/data/training tradeoff. (The head/data/training tradeoff is the analytical process of determining the MOTD elements to be presented in the TM and those to be presented in the training course.) Content generating activities (shown in Figure 3-14) are divided into prewriting tasks consisting of MOTD proposal preparation and development of publication planning documents; writing tasks during which original MOTD is generated using TM Presentation Techniques Handbooks and Writers' Guides for Readability and Comprehensibility (Text and Graphic); and postwriting tasks during which MOTD maintenance is performed.

Content Generation Objectives - The objective of the content generator is to develop adequate, accurate, and effective MOTD to be used by operation and maintenance personnel located at fleet and shore-based stations. The effect of well-designed and fully detailed data acquisition rules (MOTD specifications and standards) is significantly diluted when implemented by a content generating activity which intentionally or inadvertently fails to apply and augment these rules. While the timely availability and usefulness of the content generation output may be enhanced via the operation of effective and efficient capture, replication, and distribution functions, basic MOTD quality has already been determined.

Adequate MOTD provides the user with sufficient quantities of information which address the operation and maintenance tasks to be performed. Items such as completeness, consistency, and coverage of system/equipment interfaces impact the user's ability to perform. Accuracy involves the technical correctness of the MOTD. The level of MOTD accuracy impacts user proficiency of task performance. Effective MOTD achieves the balance among various combinations

of user personnel characteristics, job tasks, environmental conditions, and technical information presentation techniques required for efficient task performance. The major consequence of ineffective MOTD is decreased fleet operational readiness and increased system/equipment support life cycle costs.[1]

Content Generation Problems - The four main problems encountered in the creation of MOTD content are: (1) The engineering/manufacturing data bases are created for design disclosure purposes and to support equipment fabrication and test, and consequently, are not well oriented toward the generation of MOTD, (2) No systematic process exists for the extraction of data from the maintenance engineering analysis and the engineering/manufacturing data bases for conversion into technical manuals, (3) no formal interface exists between TM developers and trainers, and (4) Validation and verification do not accomplish even their limited goals of assuring completeness and accuracy.

MOTD content is developed from data bases that include system and equipment specifications, engineering drawings, commercial manuals, and various other documents. Engineering drawings and specifications that are prepared with only the data necessary to build and test the hardware in a factory do not contain the detail or emphasis that is needed in technical manuals, and often contain manufacturing process notes that are of no use to the MOTD developers or users. The REM Company task reports[2] developed for the Naval Air Development Center and sponsored by NTIPP include illustrations of this mismatch, which contributes to the high cost of the "MOTD transformation process." These reports also cite cases where data essential to MOTD development is sometimes omitted from the CDRL entirely. For example, CDRLs have been written that require technical manuals, but not a Logistic System Analysis. Without benefit of a formal maintenance task analysis, the MOTD developed has little chance of meeting the user needs.

The current content generation process consists mainly of writers attempting to fill topics from a specification outline with appropriate segments of modified source data. In this process, the writers seldom consider the possible use of the same data segments for training material. Therefore, the exact same data segments are often separately transformed into training materials. This dual effort results in the same material being covered both in the TM and the training course, but in completely different methods. Other times, it is found that material is in both the TM and training program when it should only be in one area. These problems result from the lack of an

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[1] Genovese, J.J., "Technical Manual Requirements, A Significant Element In Life Cycle Costing," Proceedings of NSIA Symposium on Technical Publications and the New User Profile, Washington, D.C., October 1975

[2] Martin, A.C., Johnson, F., Meyer, W.J.; "A Critical Evaluation of the Technical Data Development Processes for the Preparation of Technical Manuals and Training for Maintenance, Task 1-4 Reports," REM Company, 1975 (sponsored by the NTIPP Project Office at DTNSRDC)

3.3.0 DEFINITION AND OBJECTIVES OF CONTENT GENERATION (Continued)

integrated effort during the planning of the TM and training program (head/data/training tradeoff). As indicated by the NTMS Project Office, a stronger interface between the training community and the technical manual design activity (content generator) is required.[1]

Furthermore, current validation, verification, and review processes do not effectively measure technical manual content for completeness, technical and operational accuracy, and user effectiveness. Validation is often accomplished at a point in hardware development when engineering changes are in process. Equipment is seldom made available solely for validation purposes. The results are that many technical manuals are only partially validated on equipment, while the remainder are validated by simulation, or by comparison to source data. The validation effort concentrates on the accuracy of the data presented, but does not address specific criteria to determine if all required data is present, or if any of the data is unnecessary. Verification often is merely a reiteration of the validation effort. A truly effective verification process should address technical manual usability, as well as completeness and accuracy. Therefore, a method should be established to accomplish all technical documentation verifications with full participation of users operating in the maintenance environment. Additionally, verification of technical documentation which is to be used in both maintenance and training environments should include training personnel.

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[1] "Implications of Technical Manual/Navy Training Interfaces for Navy Technical Manual System (NTMS) Concept Formulation," NTMS Project Office, September, 1975

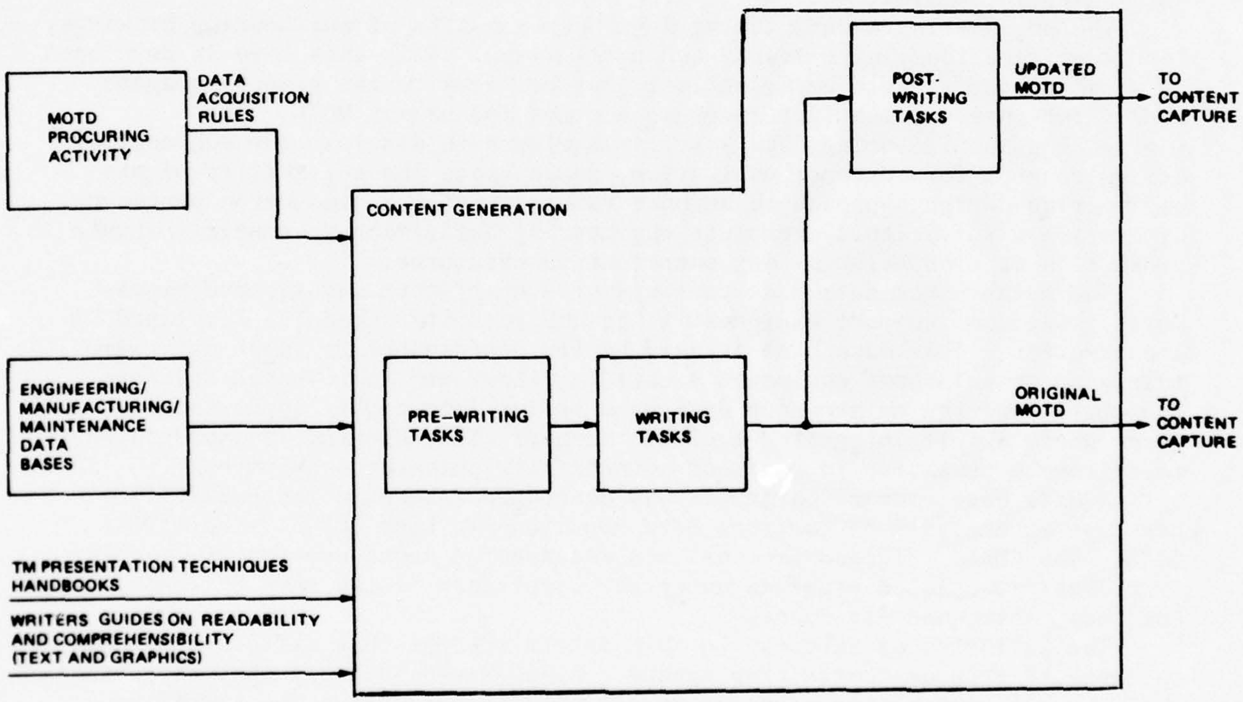


Figure 3-14. Content Generation Function. The Content Generator provides a human transformation of engineering/manufacturing/maintenance data into MOD to be used for operation and maintenance at fleet and shore based stations.

3.3.1.1 CONTENTS AND FEATURES OF ENGINEERING/MANUFACTURING/MAINTENANCE DATA BASES

Since the engineering/manufacturing/maintenance data bases are developed for the express use of those disciplines, these data bases do not adequately address the needs of the content generator. As a result, the transformation of these data bases into usable MOTD is often ineffective and expensive.

The engineering/manufacturing/maintenance data bases are critical driving inputs to the content generator, because they are his sole source of system/equipment description. These data bases are used by the content generator to develop MOTD cost estimates and program planning documents (MOTD book plans/outlines) during the prewriting tasks. Additionally, the writing tasks consist largely of a transformation of the information contained in these data bases into MOTD.

The engineering/manufacturing data base consists of engineering drawings, test specifications, wire lists, and parts lists. This data base is developed by a contractor's engineering activity for delivery to the procuring agency and/or for internal manufacturing use and not for use as MOTD. The engineering/manufacturing data base is developed to disclose the engineering design concept for customer evaluation, demonstrate the suitability of the engineering design approach to support manufacture of a production prototype, or provide a sufficiently complete engineering definition to enable in-house production or production by any competent manufacturer.

The maintenance data base consists of step-by-step maintenance procedures, diagrams, support equipment lists and activity schedules developed by a contractor. This data base is used by field personnel to check out, maintain, and troubleshoot equipment located at fleet and shore-based stations. The quality of the maintenance data base varies from highly sophisticated, in cases where a full Integrated Logistic Support (ILS) Program is implemented, to extremely primitive in cases of commercially purchased equipment.

A data base comparison matrix was developed (shown in Table 3-XVII) based on an analysis of Contract Data Requirements List (CDRL) - Form DD-1423. The CDRLs selected for analysis represent a cross-section of on-going or recently completed programs under the cognizance of the Navy Systems Commands, Army, and Air Force.

The variables of interest in this matrix are possible differences based on contract type or contracting agency. Since MIL-D-1000 was applied consistently by all contracting agencies to all contractors during the timeframe in question, the programs in the matrix were deliberately selected from a single contractor (Hughes Aircraft Co.). This analysis was designed to afford a reasonable cross-section of program types and contracting agencies for review.

There appear to be no significant differences in the engineering/manufacturing data bases that are attributable to the requirements of the procuring military agency. However, some differences in the data bases can be observed based on the requirements of the engineering/manufacturing disciplines attendant to different types of programs (developmental, prototype, production). In addition, an examination of the actual data developed on the programs under analysis (engineering drawings, test specifications, etc.) revealed virtually no differences in the data base quality, format, and media.

The comparison matrix depicts data bases meeting the requirements of the now-obsolete MIL-D-1000 specification which was superseded on 15 October 1975 by MIL-D-1000A. At the present time, little historical data exists for data bases procured under MIL-D-1000A. However, the nature of the differences between old MIL-D-1000 and new MIL-D-1000A do not appear to increase the utility of the data base to the content generator. As a result, no improvement is expected in the cost-effectiveness of the transformation of the engineering/manufacturing data base into usable MOTD.

In addition to the previously described deliverable data base, most military contractors develop a nondeliverable data base for internal use. This nondeliverable data usually consists of items such as functional block diagrams, timing diagrams, and detailed circuit descriptions which are specifically oriented toward meeting the requirements of maintenance personnel such as field engineers. As a result, the nondeliverable data base is often more compatible with the content generation transform than is the deliverable data base.

An analysis of the time-phasing relationships between the development of the engineering/manufacturing/maintenance data bases and the development of MOTD by the content generator reveals the lack of an efficiently coordinated effort. As a result, the content generating activity is often forced either to function with an inadequate data base or to compress MOTD development into an abbreviated and less effective timeframe. In addition, this lack of proper time-phasing relationships sometimes leads to duplication of effort between the content generating activity and maintenance engineering.

TABLE 3-XVII. COMPARISON OF DATA BASE CONTENTS BY CONTRACT TYPE AND CONTRACTING AGENCY

Procuring Agency	Program		Drawing		Reproduction	
	Name	Type	Form[1]	Category[2]	Type[3]	Class[4]
NAVAIR	A-6 Tram	Developmental	2,3	A,B	I,II	1
	A-6 Tram	Prototype	2	D,E,F,H,I	II	2,3
	A-6 Tram	Production	2	D,E,F,H,I	II	3
	Phoenix	Developmental	2,3	A,B	I,II	1
	Phoenix	Prototype	2	D,E,F,H,I	II	2,3
	Phoenix	Production	2	D,E,F,H,I	II	3
NAVELEX	AN/PRC-104	Developmental	3	A	I,II	1
	AN/PRC-104	Prototype	2	D,E,G	II	2,3
	AN/PRC-104	Production	2	D,E,G	II	3
	SURTASS	Developmental	3	A,B	II	1
	SURTASS	Prototype	2	E	II	1
	SURTASS	Production	2	E	II	3
NAVSEA	MK 113 MOD 10	Developmental	3	A,B	II	1
	MK 113 MOD 10	Prototype	1	D,E,F,G,H	II	2,3
	MK 113 MOD 10	Production	1	D,E,F,G,H	II	3
	MK 97 (SID)	Developmental	3	A,B	II	1
	MK 97 (SID)	Prototype	1	D,E,F,G,H	II	2,3
	MK 97 (SID)	Production	1	D,E,F,G,H	II	3
	AN/SPS-52	Developmental	3	A,B	II	2
	AN/SPS-52	Prototype	1	D,E,G	II	2,3
	AN/SPS-52	Production	1	D,E,G	II	3
	MK 82	Developmental	3	A,B	I,II	1
	MK 82	Prototype	1	C,D,E,H	II	1,3
	MK 82	Production	1	C,D,E,H	II	3
Air Force	407L	Developmental	3	A,B	II	1
	407L	Prototype	1	D,E,F,H,I	II	3
	407L	Production	1	D,E,F,H,I	II	3
	TACS/TADS	Developmental	3	A,B	II	1

	MK 97 (SID)	Developmental	3	A,B	II	1
	MK 97 (SID)	Prototype	1	D,E,F,G,H	II	2,3
	MK 97 (SID)	Production	1	D,E,F,G,H	II	3
	AN/SPS-52	Developmental	3	A,B	II	2
	AN/SPS-52	Prototype	1	D,E,G	II	2,3
	AN/SPS-52	Production	1	D,E,G	II	3
	MK 82	Developmental	3	A,B	I,II	1
	MK 82	Prototype	1	C,D,E,H	II	1,3
	MK 82	Production	1	C,D,E,H	II	3
Air Force	407L	Developmental	3	A,B	II	1
	407L	Prototype	1	D,E,F,H,I	II	3
	407L	Production	1	D,E,F,H,I	II	3
	TACS/TADS	Developmental	3	A,B	II	1
	TACS/TADS	Prototype	1	D,E	II	2
	TACS/TADS	Production	2	D,E	II	2,3
Army	PLRS*	Developmental	3	A	II	2
	PLRS	Prototype	1	E	II	2,3
	PLRS	Production	1	E	II	3
	AN/TPQ-36	Developmental	3	A	II	2
	AN/TPQ-36	Prototype	1	E	II	2,3
	AN/TPQ-36	Production	1	E	II	3

*Position Locating and Reporting System

1. Form of Drawings (MIL-D-10000)

Form 1 - Drawings to Military Standards
Form 2 - Drawings to Industry Standards (Partial Military Controls)
Form 3 - Drawings to Industry Standards (Minimum Military Controls)

2. Categories of Drawings (MIL-D-1000)

A - Design Evaluation
B - Interface Control
C - Service Test
D - Logistic Support
E - Procurement (Identical Item)
F - Procurement (Interchangeable Item)
G - Installation
H - Maintenance
I - Government Manufacture
J - Interchangeability Control

3. Reproduction Requirements (MIL-M-5480E)

Type I - Nondrawing Copy
Type II - Drawing Copy

4. Reproduction Requirements (MIL-M-5480E)

Class 1 - Nonreproduceable
Class 2 - Reproduceable
Class 3 - Microfilm (Reference Only)
Class 4 - Duplicate Originals

3.3.1.2 MANUAL VERSUS COMPUTER-AIDED DATA BASES

The engineering/manufacturing data bases provided to the content generator for use in MOTD generation have traditionally been developed manually. However, the current trend is toward computer-aided data base development.

The manual process of developing the engineering/manufacturing data bases (shown in Figure 3-15) has not changed significantly over the decades of its use. The only noticeable change of any consequence has been the increased use of microform as the data base media. Most of today's manual data base systems output data to the content generator in both hard copy (paper) and microform (aperture cards) which can be converted to hard copy if necessary. This dual media aspect of the current manual data base system provides flexibility which did not previously exist. The content generator can scan the aperture card data on a viewer if it is needed only for quick reference (such as in the case of parts lists); yet, he retains the option of requesting or converting to hard copy for detailed analysis. This process is cost-effective because time is not wasted recording, filing, storing, and handling cumbersome paper copies of material which may be needed only briefly.

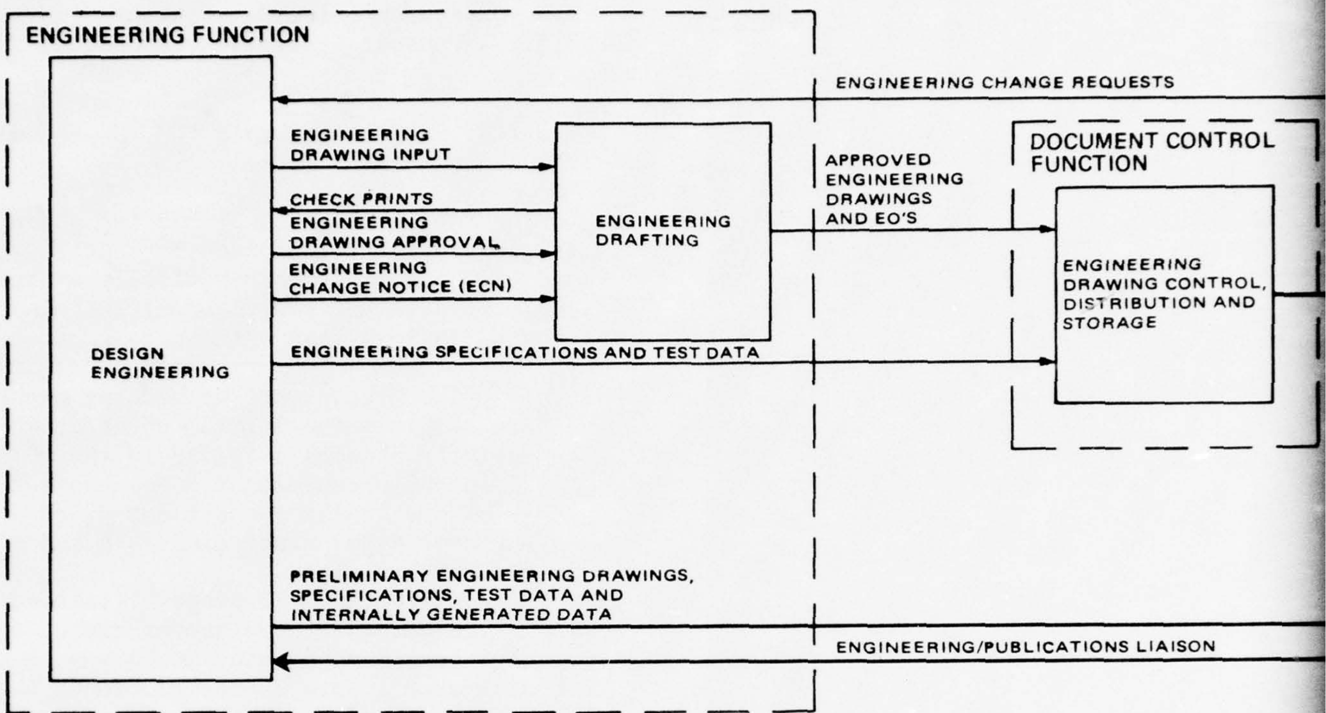
The manual data base system relies upon the human being as its prime communication element. As a result of the numerous human interfaces, this system is prone to error, slow in developing the original data base, and even slower in documenting changes. An example of the consequences is the burgeoning expansion of control documentation which is required for data base development and change. This control documentation exists for the dual purposes of configuration management and reduction of the number of errors that data base developers inadvertently infuse into the released data. Consequently, long time delays develop between the creation of original or revised data base items, and the delivery of same to the content generator.

An additional disadvantage related to the human communication element of the manual data base system is that each engineering discipline (electrical, electronic, mechanical, hydraulic) has developed its own unique set of terminology, symbology, and methods of data presentation. Such intramural jargon does not assure communication either with the content generator or with the end user in the field, both of whom may lack the required familiarity. For example, the mechanical engineering discipline uses two-dimensional sectional views to represent parts location information. However, both content generation and field maintenance personnel can usually treat this information more effectively in three-dimensional exploded views.

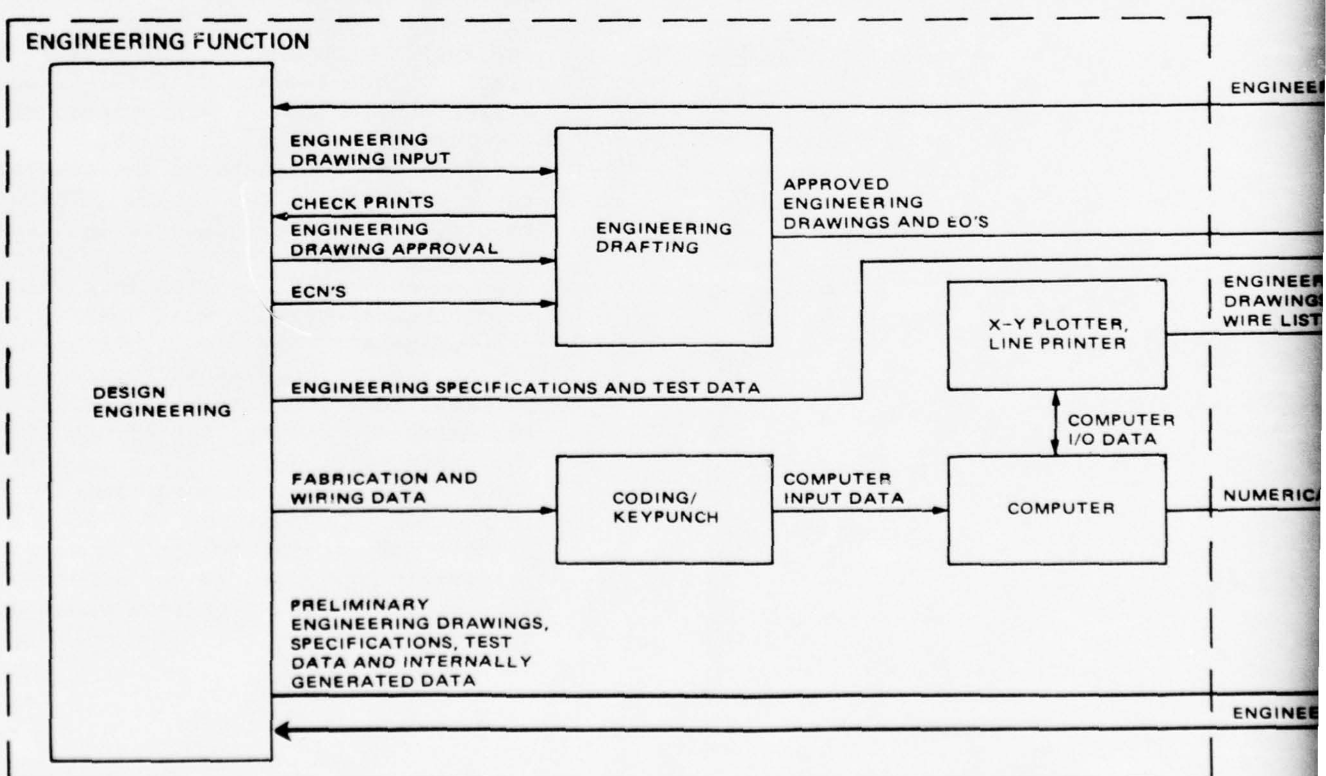
Numerical control machines and the computer have provided the tools required to automate a portion of the engineering/manufacturing data base development process. This type of automation reduces to a limited extent the manual aspects of data base generation. The time required to design, develop, and manufacture a system/equipment is decreased by automating many of the tasks performed by mechanical designers and manufacturing planners. In addition to saving time, errors in fabrication are also reduced by the repeatability feature of numerical control, as compared to the human element.

Computer-aided data base development has penetrated the manufacturing process in areas of sheet metal parts fabrication, mechanical parts, back-plane assembly wiring for interconnecting printed circuit cards, flame-cutting and welding structural assemblies, and any process that is adaptable to precise or repeatable steps in manufacture.

Insofar as the content generator is concerned, computer-aided data base generation has provided no real relief to the MOTD development problems of (1) a limited data base generated primarily to satisfy engineering and manufacturing requirements, and (2) currency and availability of the data base. Solutions to the content generation data base problems expected to appear with the emergence of the computer-aided data base have not manifested themselves to date.



MANUALLY GENERATED DAT



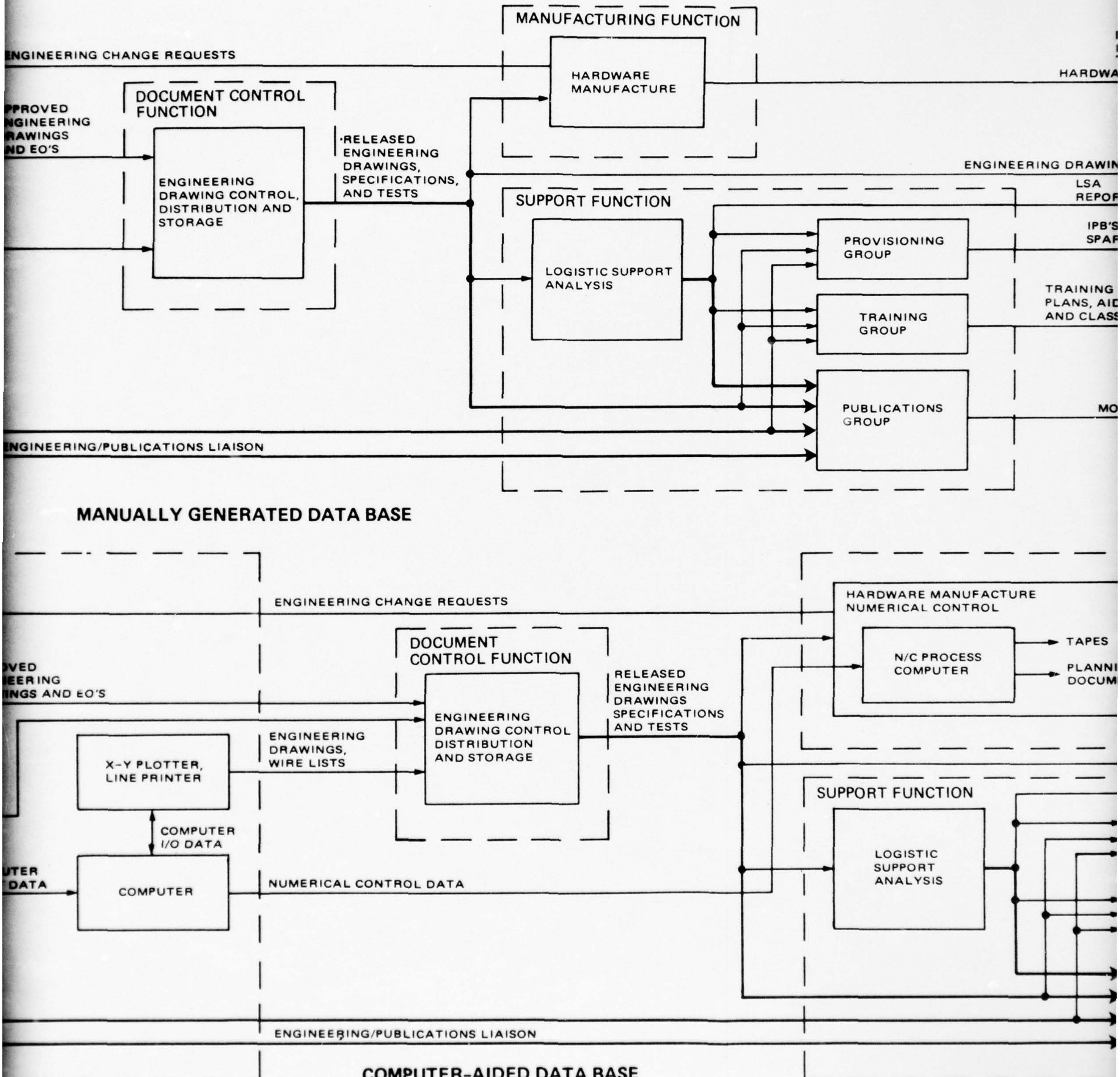


Figure 3-15. Manual and Automated Data Base Pr
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content generation difficulties have not been

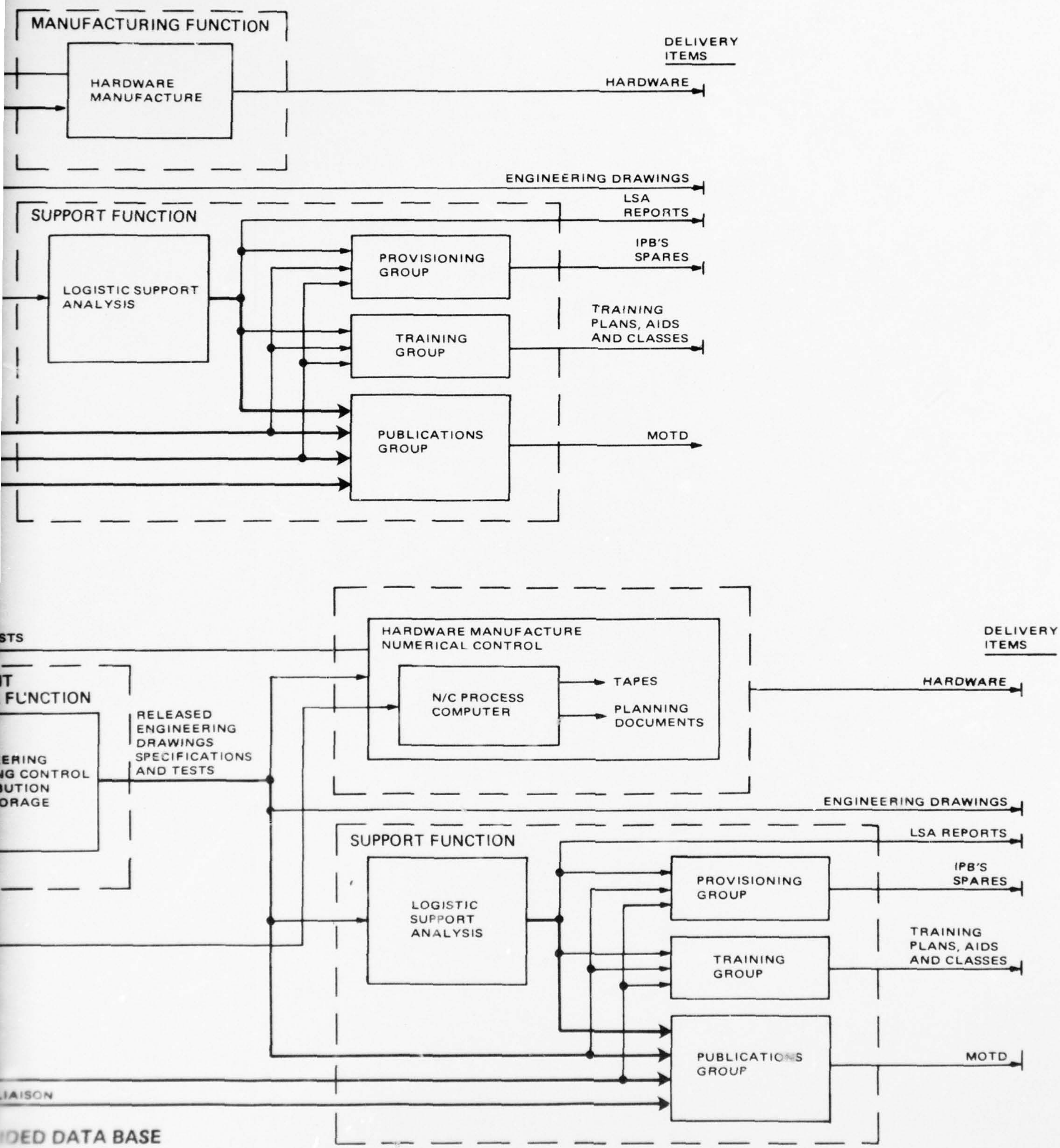


Figure 3-15. Manual and Automated Data Base Processes. While data base automation has benefitted Engineering and Manufacturing operations, the hoped-for solutions to content generation difficulties have not been realized.

3.3.1.3 PREWRITING TASKS FOR THE PRECONTRACT OR BIDDING PHASE

During the precontract or bidding phase of the prewriting tasks, the content generating activity is forced to react to considerations which it cannot influence and of which it is only minimally aware. A lack of clear relationships between logistic data and equipment life-cycle costs result in these data items being treated in less than optimum fashion.

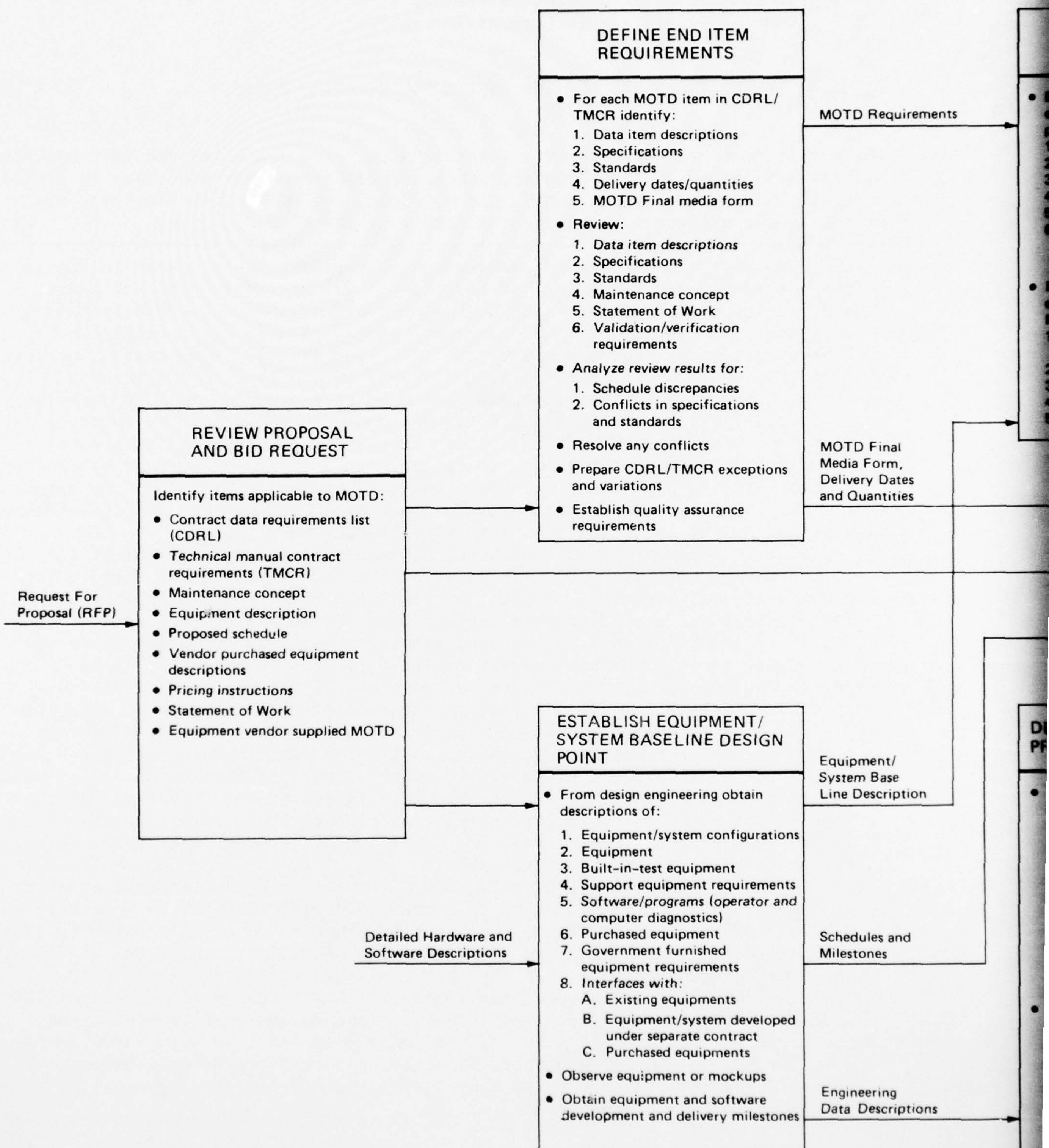
The precontract or bidding phase of the prewriting tasks (shown in Figure 3-16) is the initial point at which the contractor's content generating activity becomes involved in the MOTD development cycle for new system/equipment procurements. The content generator uses the data acquisition rules specified in the request for proposal (RFP), in conjunction with the minimal engineering/manufacturing data bases available at this time, to develop an MOTD bid package.

Since the MOTD proposal is required by the procuring activity early in the hardware development cycle, only an incomplete, relatively undefined engineering/manufacturing data base is available for review. This forces the estimator into a series of creative guesses as to equipment complexity and difficulty of presentation development, often resulting in inaccurate estimates of MOTD page counts and manhours. The consequences can be particularly acute when dealing in high-technology areas where the state-of-the-art is extremely dynamic. The tendency to compensate by overbidding is tempered by the realization that an unrealistic bid will probably not result in a contract. Since the aim of the contractor is to stay within budget, the only variable which can be manipulated after contract award is MOTD quality, in the form of depth of coverage, with a resultant impact on page count. Compromises and shortcuts in the development cycle often cause ineffective MOTD to be deployed in the field. Ultimately higher equipment life-cycle costs result, due to the increased maintenance time required to compensate for MOTD deficiencies.

An additional problem in developing a realistic MOTD proposal is that the content generator must operate in a purely reactive mode. The content generating activity has no direct impact on the timing, quality, or content of the engineering/manufacturing/maintenance data bases. The content generator must function with whatever data is developed, whenever it is available. For example, testing, troubleshooting, and alignment procedures development by the engineering activity are usually compatible with the factory environment, but may be totally inappropriate in the field environment due to differences in available support and test equipment. In addition, the questionable value of this data to the content generator is further diluted by the fact that it is usually developed rather late in a program, when the emphasis is on factory testing. These factors cause estimating MOTD development to be extremely hazardous.

An additional problem exists in that "estimating guesses" make it extremely difficult to determine the adequacy of MOTD bidding procedures due to the lack of traceable underlying rationale. This problem is compounded by the fact that while actual costs may correspond to estimated costs, this is often a forced fit, attributable to manipulations of MOTD quality rather than the accuracy of the estimate.

The data acquisition rules are contained in the RFP in the form of specifications, data item descriptions (DIDs), and technical manual contract requirements (TMCRs). In the event that the MOTD specification is inadequate or inappropriate for the system/equipment or maintenance philosophy in question, the burden is placed upon the content generator to propose waivers or deviations. Should the contractor lack the creativity, knowledge, or conscientiousness to respond in this manner, a severe MOTD mismatch results.


DEFINE END ITEM REQUIREMENTS
• For each MOTD item in CDRL/TMCR identify:
1. Data item descriptions
2. Specifications
3. Standards
4. Delivery dates/quantities
5. MOTD Final media form
• Review:
1. Data item descriptions
2. Specifications
3. Standards
4. Maintenance concept
5. Statement of Work
6. Validation/verification requirements
• Analyze review results for:
1. Schedule discrepancies
2. Conflicts in specifications and standards
• Resolve any conflicts
• Prepare CDRL/TMCR exceptions and variations
• Establish quality assurance requirements
MOTD Requirements
MOTD Final Media Form, Delivery Dates and Quantities
REVIEW PROPOSAL AND BID REQUEST
Identify items applicable to MOTD:
• Contract data requirements list (CDRL)
• Technical manual contract requirements (TMCR)
• Maintenance concept
• Equipment description
• Proposed schedule
• Vendor purchased equipment descriptions
• Pricing instructions
• Statement of Work
• Equipment vendor supplied MOTD
Request For Proposal (RFP)
ESTABLISH EQUIPMENT/ SYSTEM BASELINE DESIGN POINT
• From design engineering obtain descriptions of:
1. Equipment/system configurations
2. Equipment
3. Built-in-test equipment
4. Support equipment requirements
5. Software/programs (operator and computer diagnostics)
6. Purchased equipment
7. Government furnished equipment requirements
8. Interfaces with:
A. Existing equipments
B. Equipment/system developed under separate contract
C. Purchased equipments
• Observe equipment or mockups
• Obtain equipment and software development and delivery milestones
Detailed Hardware and Software Descriptions
Equipment/ System Base Line Description
Schedules and Milestones
Engineering Data Descriptions

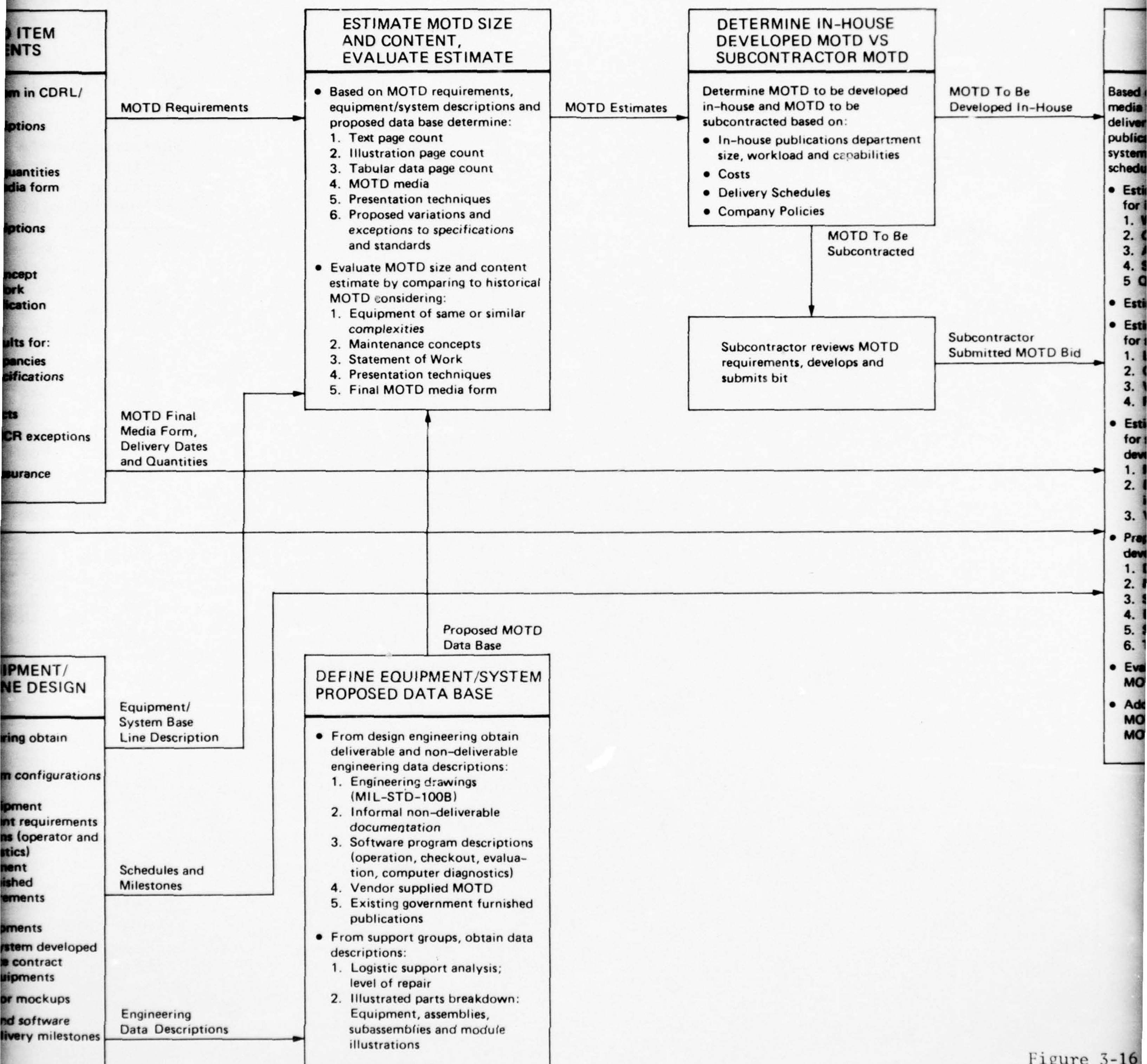


Figure 3-16
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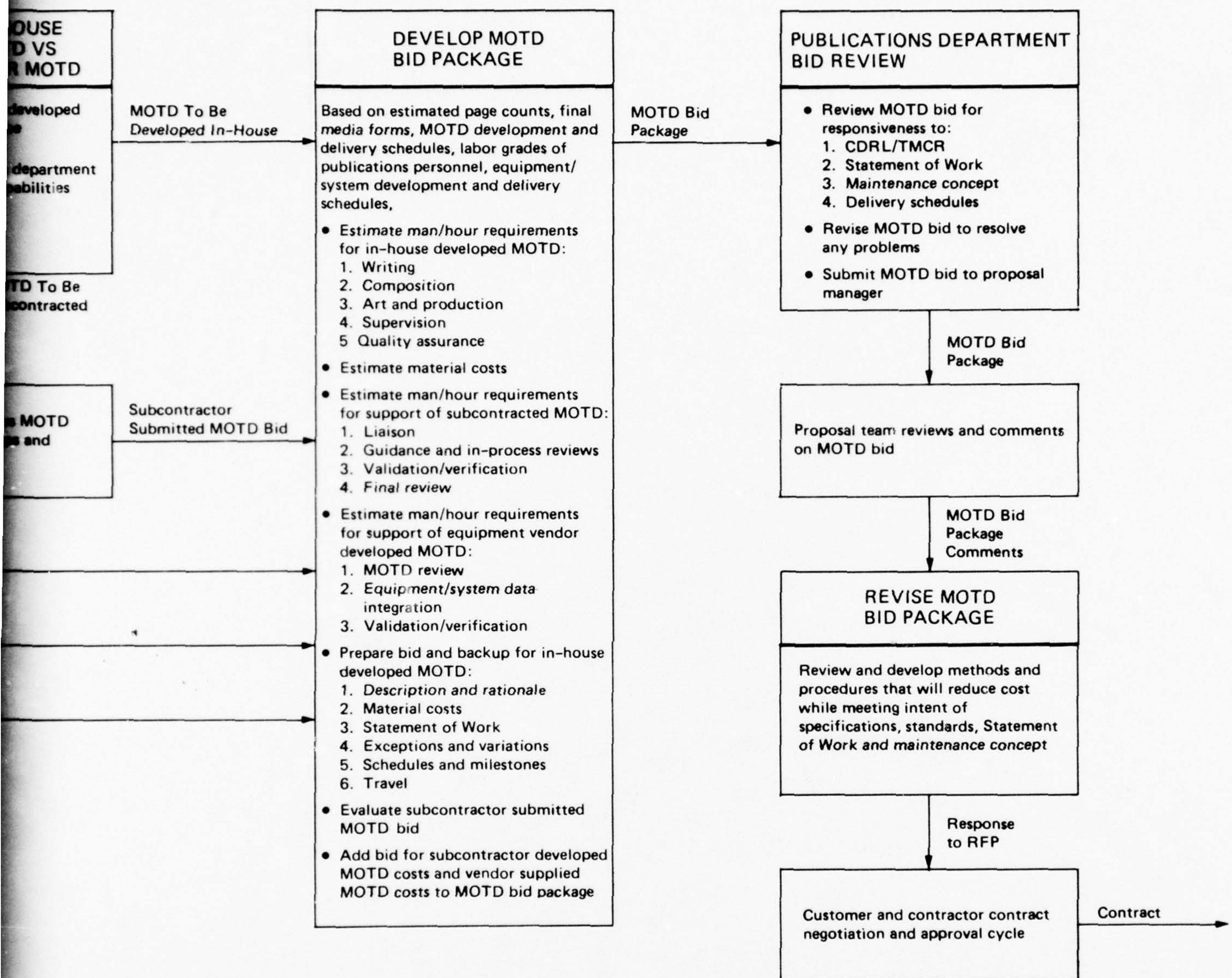


NOTE:

This diagram represents the maximum configuration. Tasks shown may be done in truncated form depending on size of contractor, size of contract, and method of conducting business.

Figure 3-16. Prewriting Tasks, Precontract or Bidding Phase. Difficulties and inaccuracies in the estimation of costs and schedules are attributable to the lack of firm definition of data base and equipment characteristics at the time of the estimate.

3.3.1.4 PREWRITING TASKS FOR THE POST-CONTRACT AWARD PHASE

The requirements for development of technical publication plans and MOTD bookplans/outlines do not provide the content generator with the tools necessary to produce effective MOTD planning documents. As a result, the MOTD plans developed are of minimal value either to the reviewing agency or the MOTD developer.

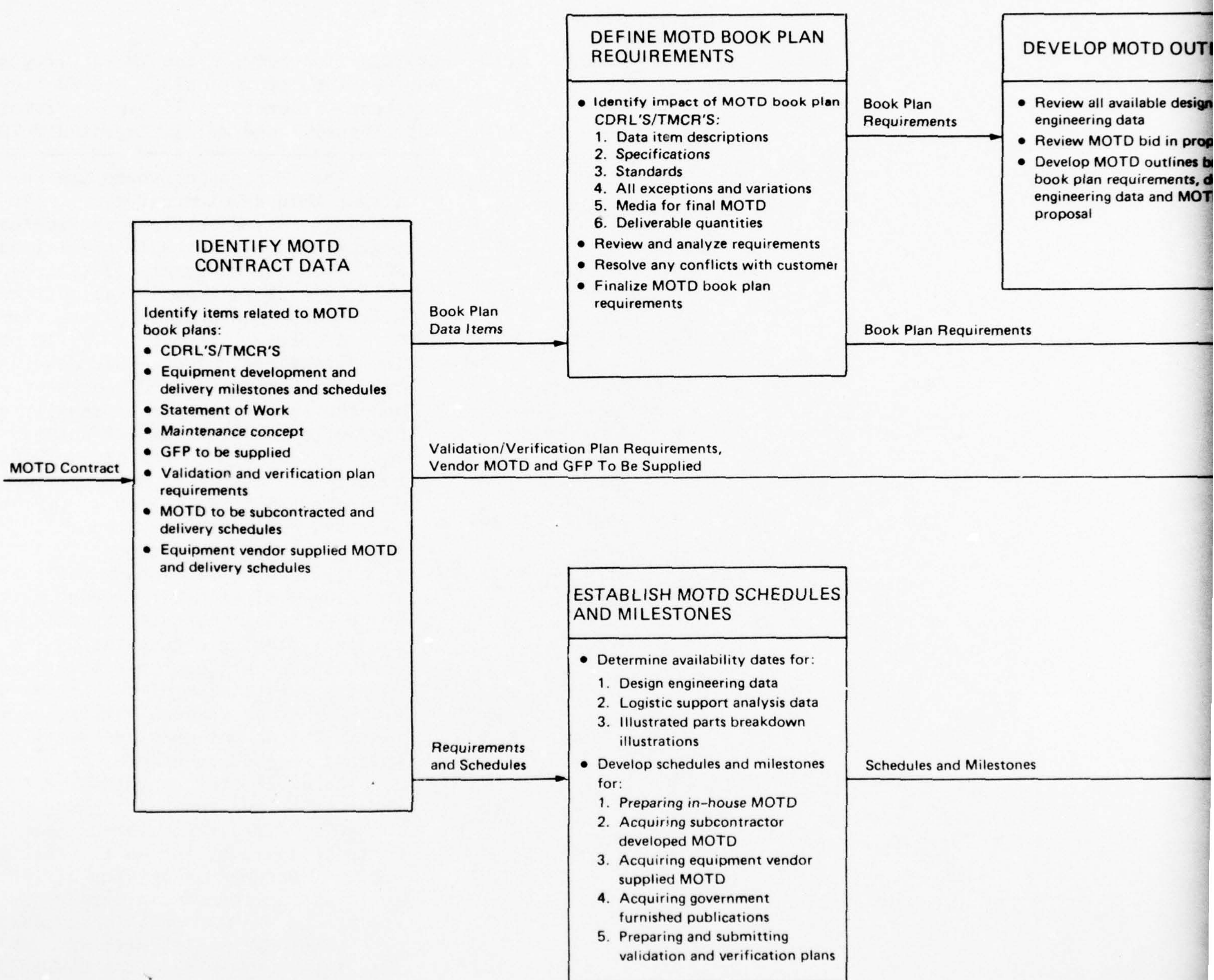
The post-contract award phase of the prewriting tasks (shown in Figure 3-17) normally occurs during the first 30 to 60 days after contract award. This is the period during which technical publication plans, MOTD bookplans/outlines, and preliminary MOTD schedules and milestones are developed by the content generator and approved by the reviewing agency. A technical publication plan contains information as to the number and type of TMs to be developed for each of the systems and/or equipments being procured. An MOTD bookplan/outline details in very general terms the contents of each TM by chapter, section, and paragraph and often includes samples of the types of procedures, descriptions, and illustrations to be included. After development by the contractor, the MOTD planning documents are reviewed and approved by the cognizant military agency. These approved MOTD plans are then used by the content generator and by the reviewing agency as a monitoring baseline.

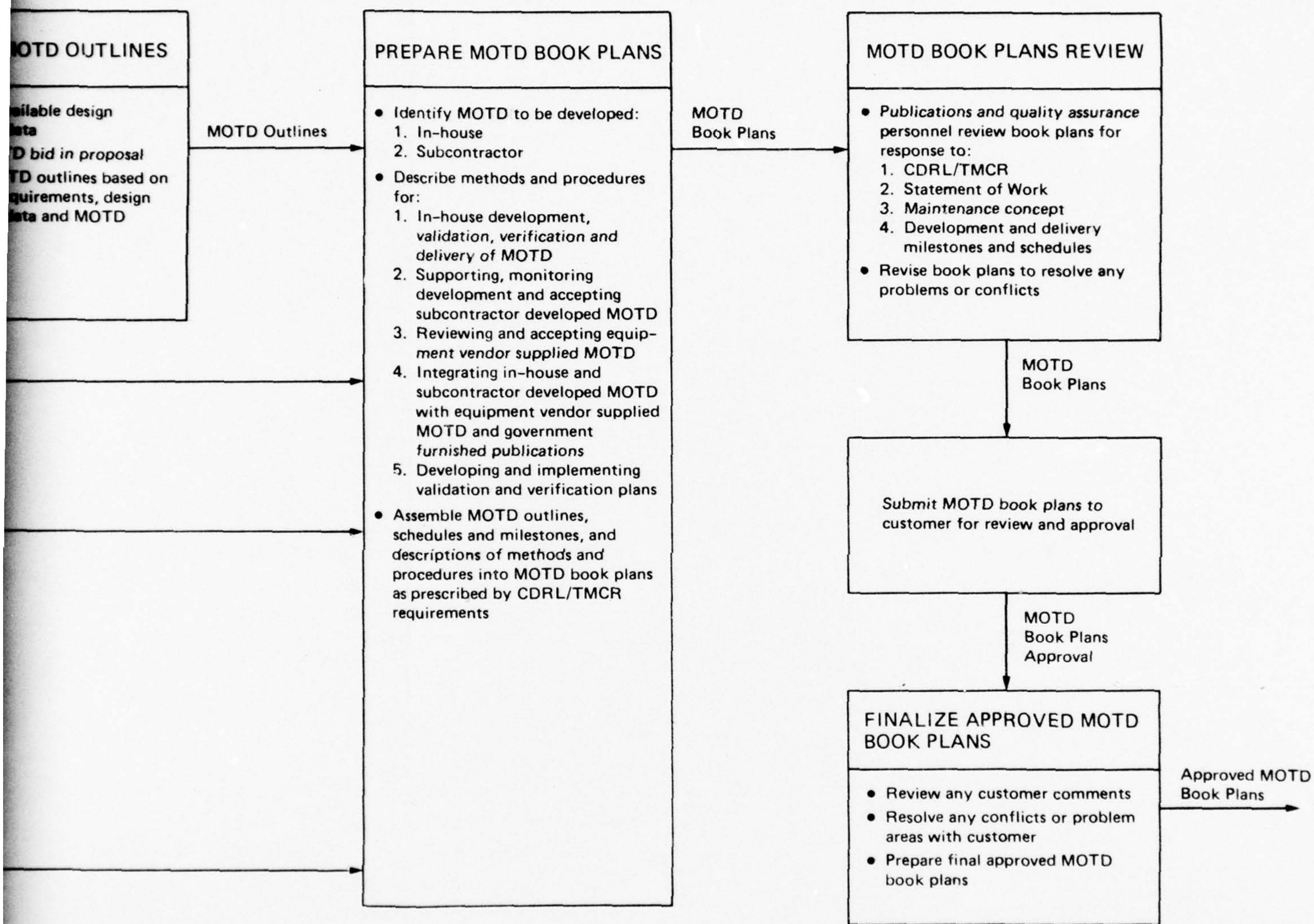
The development of MOTD planning documents is the critical first step in the development of MOTD which is effective and usable in the field. The problem is that technical publication plans and MOTD bookplans/outlines are vague, nondetailed, and usually contain only "boilerplate" information. Due partially to the minimal engineering/manufacturing data bases available at this time, these documents are not designed for the specific TMs to be developed, and merely repeat what is contained in the MOTD specification. Interviews with personnel involved in the generation and review of MOTD planning documents reveal that documents of this type, generated for different programs involving totally dissimilar systems/equipments but using the same MOTD specifications, are virtually identical. Most of the content description for each chapter, section, and paragraph is lifted almost verbatim from the specification. Samples of procedures, descriptions, and illustrations are lifted from previously generated TMs developed for systems/equipments which are at best only minimally applicable.

Because adequate MOTD planning and outlining is both difficult and time-consuming, contractors will tend to avoid performing this task. Moreover, no evidence exists to demonstrate that they know how to do it correctly, or that they are sufficiently required to do so. The specifications, DIDs, and TMCRs which dictate the requirements for technical publication plans and MOTD bookplans/outlines do not tell the contractor how to correctly develop these documents, nor do they adequately constrain and define what is acceptable. Use of these specifications, DIDs, and TMCRs does not result in sufficiently detailed MOTD planning documents, tailored to specific systems/equipments and presentation techniques because they themselves are extremely general in nature and do not address specifics.

Due to these inadequacies in the MOTD planning documents developed by the contractor, the reviewing agency is hampered in evaluating the quality of these documents and in determining what the TMs will actually contain. This results in technical publication plans and MOTD bookplans/outlines being approved on a "wait and see" basis. However, when problems and conflicts arise downstream in the MOTD development process, the allotted funds have already been largely expended. Due to the trend toward fixed price contracts, this often results in an impasse between the contractor and the reviewing agency. This impasse is usually settled by compromises which impact the quality of the MOTD.

Vague and nondetailed MOTD planning documents also affect the TM writer, who frequently finds himself without the direction necessary to develop quality MOTD. This lack of direction results in inconsistent, incomplete, and inaccurate products. MOTD inadequacies are hence a consequence of the present lack of adequate planning documents which can be used effectively by both the acquiring agency and the contractor's content generator.


DEFINE MOTD BOOK PLAN REQUIREMENTS
• Identify impact of MOTD book plan CDRL'S/TMCR'S:
1. Data item descriptions
2. Specifications
3. Standards
4. All exceptions and variations
5. Media for final MOTD
6. Deliverable quantities
• Review and analyze requirements
• Resolve any conflicts with custome
• Finalize MOTD book plan requirements
Book Plan Requirements
DEVELOP MOTD OUT
• Review all available design engineering data
• Review MOTD bid in prop
• Develop MOTD outlines b book plan requirements, d engineering data and MOT proposal
IDENTIFY MOTD CONTRACT DATA
Identify items related to MOTD book plans:
• CDRL'S/TMCR'S
• Equipment development and delivery milestones and schedules
• Statement of Work
• Maintenance concept
• GFP to be supplied
• Validation and verification plan requirements
• MOTD to be subcontracted and delivery schedules
• Equipment vendor supplied MOTD and delivery schedules
Book Plan Data Items
Book Plan Requirements
MOTD Contract
Validation/Verification Plan Requirements, Vendor MOTD and GFP To Be Supplied
ESTABLISH MOTD SCHEDULES AND MILESTONES
• Determine availability dates for:
1. Design engineering data
2. Logistic support analysis data
3. Illustrated parts breakdown illustrations
• Develop schedules and milestones for:
1. Preparing in-house MOTD
2. Acquiring subcontractor developed MOTD
3. Acquiring equipment vendor supplied MOTD
4. Acquiring government furnished publications
5. Preparing and submitting validation and verification plans
Requirements and Schedules
Schedules and Milestones



NOTE:
This diagram represents the maximum configuration. Tasks may be done in truncated form depending on size of contractor, size of contract and method of conducting business.

Figure 3-17. Prewriting Tasks, Postcontract Award Phase. The lack of sufficiently detailed MOTD planning documents inhibits adequate performance by both the contractor and the reviewing agency.

3.3.1.5 WRITING TASKS FOR THE TM PLANNING PHASE

Coordination between the TM activity and design engineering, training, maintenance engineering, provisioning, and quality assurance is haphazard at best and often non-existent. Therefore, little opportunity exists for the development of a concise, comprehensive and well integrated MOTD package.

The TM planning phase (shown in Figure 3-18) occurs at the start of the actual MOTD development cycle. At this point, the hardware development process has evolved into engineering/manufacturing data bases which are sufficiently complete for MOTD generation purposes. During this phase, the approved MOTD planning documents (developed in the prewriting tasks) are converted into writing work packages. Validation/verification plans, internal schedules and milestones, and program-unique writer's guides are also developed.

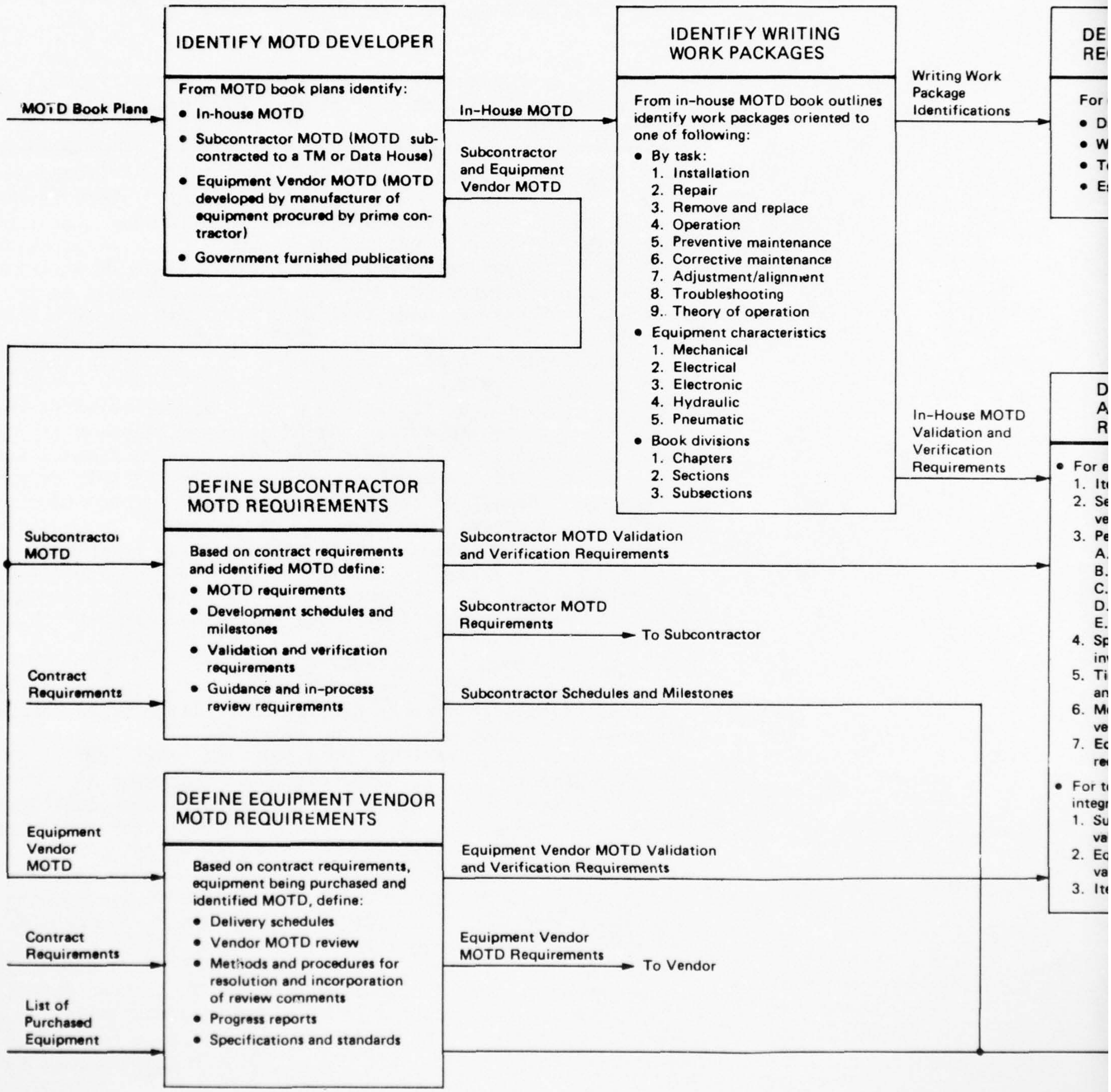
A critical aspect of the TM planning phase is the establishment of a plan for interfaces between MOTD developers and design engineers. Due to data base incompatibility with MOTD development, state-of-the-art equipment complexity, and the short time period usually allowed for MOTD generation, the MOTD developer often requires direct access to the engineers responsible for system/equipment design. Problems may occur when engineering is not contractually required to assist in MOTD development or review MOTD output. In these cases, design engineering places a very low priority on interfacing with MOTD activities and engineers are frequently not available when needed. Therefore, the MOTD developer must frequently take "educated guesses" as to equipment theory of operation or face undesirable schedule slippages.

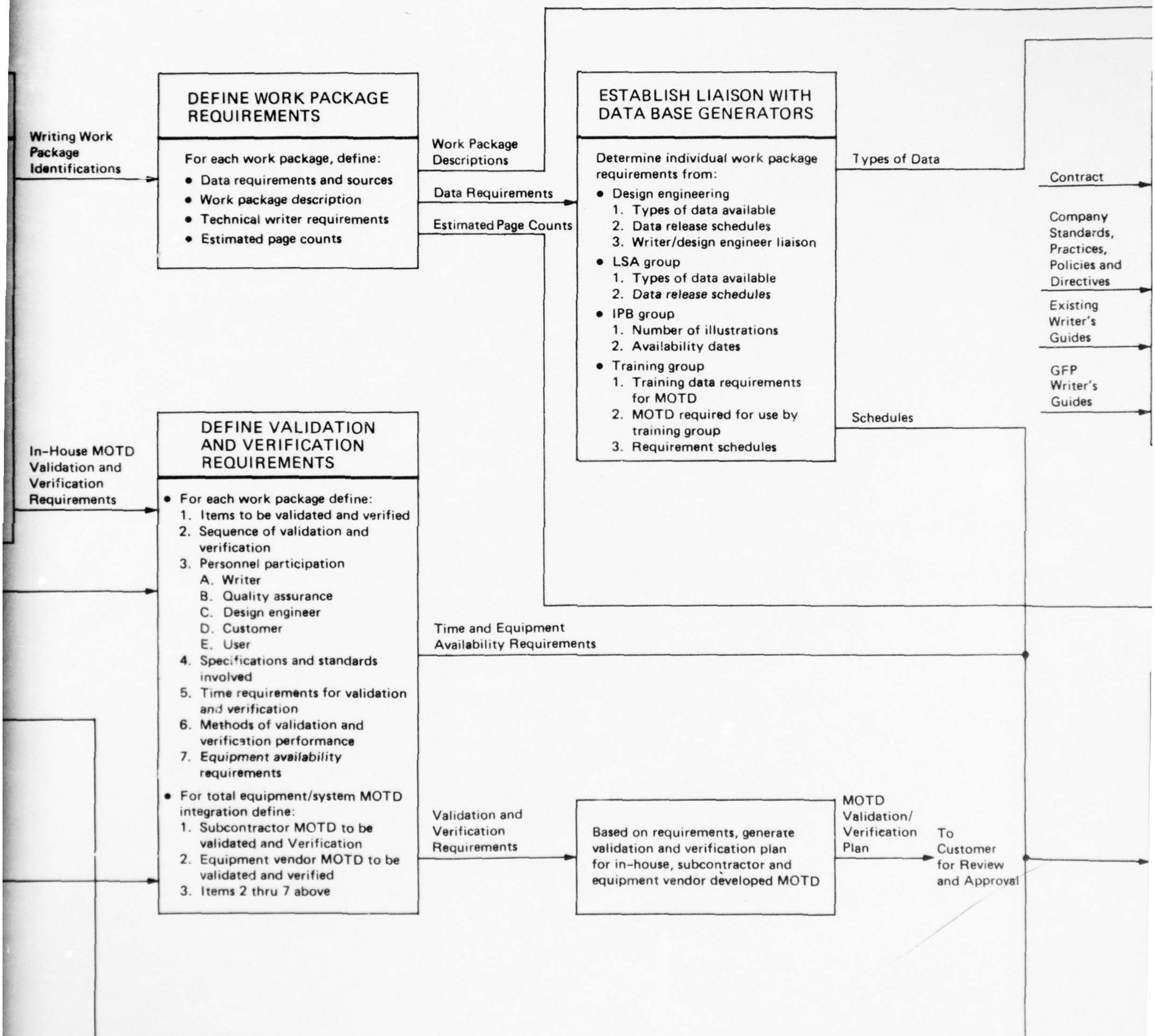
The typical military contractor maintains separate activities for developing technical manuals, training programs, maintenance engineering analyses, and provisioning documentation - a single individual having cognizance and control over all of these activities relative to a specific program does not usually exist. Therefore, formal and structured coordination of the operations of these various activities is lacking on most programs. This may result in the untimely availability of material developed by one activity which is needed by others, or (in the worst case) redundant MOTD development.

An additional coordination problem exists because interface between the TM activity and the quality assurance activity normally does not occur until the MOTD is fully developed. Lacking this guidance, the TM activity may not be fully aware of the quality assurance requirements which must be met to achieve customer acceptance of the MOTD. Gaining knowledge of these requirements at the end of a program results in a costly rewriting effort which may surface as an MOTD revision or change package.

Development of a writing work package includes selection of writing personnel to perform the task defined in each package. Unfortunately the contractor's TM activity does not usually attempt to perform a writer-work package match. Writer selection is usually based on personnel availability, with little consideration to individual skills and experience. For example, unique

engineering disciplines have developed to deal with dissimilar equipment categories such as electrical, electronic, mechanical, and hydraulic; however, the same technical writer is often required to develop MOTD for all. The same personnel generate detailed theory of operation for highly complex electronic equipment as well as mechanical type removal and replacement procedures. An additional mismatch occurs when personnel having no "hands-on" equipment experience, and/or not familiar with the field maintenance environment, are expected to develop equipment maintenance or troubleshooting procedures. The mismatching of TM writer to writing task results in the deployment of inaccurate and virtually unusable MOTD.


MOTD Book Plans
IDENTIFY MOTD DEVELOPER
From MOTD book plans identify:
• In-house MOTD
• Subcontractor MOTD (MOTD subcontracted to a TM or Data House)
• Equipment Vendor MOTD (MOTD developed by manufacturer of equipment procured by prime contractor)
• Government furnished publications
In-House MOTD
Subcontractor and Equipment Vendor MOTD
IDENTIFY WRITING WORK PACKAGES
From in-house MOTD book outlines identify work packages oriented to one of following:
• By task:
1. Installation
2. Repair
3. Remove and replace
4. Operation
5. Preventive maintenance
6. Corrective maintenance
7. Adjustment/alignment
8. Troubleshooting
9. Theory of operation
• Equipment characteristics
1. Mechanical
2. Electrical
3. Electronic
4. Hydraulic
5. Pneumatic
• Book divisions
1. Chapters
2. Sections
3. Subsections
Writing Work Package Identifications
In-House MOTD Validation and Verification Requirements
Subcontractor MOTD
DEFINE SUBCONTRACTOR MOTD REQUIREMENTS
Based on contract requirements and identified MOTD define:
• MOTD requirements
• Development schedules and milestones
• Validation and verification requirements
• Guidance and in-process review requirements
Contract Requirements
Subcontractor MOTD Validation and Verification Requirements
Subcontractor MOTD Requirements
To Subcontractor
Subcontractor Schedules and Milestones
Equipment Vendor MOTD
DEFINE EQUIPMENT VENDOR MOTD REQUIREMENTS
Based on contract requirements, equipment being purchased and identified MOTD, define:
• Delivery schedules
• Vendor MOTD review
• Methods and procedures for resolution and incorporation of review comments
• Progress reports
• Specifications and standards
Contract Requirements
List of Purchased Equipment
Equipment Vendor MOTD Validation and Verification Requirements
Equipment Vendor MOTD Requirements
To Vendor


Writing Work Package Identifications
DEFINE WORK PACKAGE REQUIREMENTS
For each work package, define:
• Data requirements and sources
• Work package description
• Technical writer requirements
• Estimated page counts
Work Package Descriptions
Data Requirements
Estimated Page Counts
ESTABLISH LIAISON WITH DATA BASE GENERATORS
Determine individual work package requirements from:
• Design engineering
1. Types of data available
2. Data release schedules
3. Writer/design engineer liaison
• LSA group
1. Types of data available
2. Data release schedules
• IPB group
1. Number of illustrations
2. Availability dates
• Training group
1. Training data requirements for MOTD
2. MOTD required for use by training group
3. Requirement schedules
Types of Data
Schedules
Contract
Company Standards, Practices, Policies and Directives
Existing Writer's Guides
GFP Writer's Guides
In-House MOTD Validation and Verification Requirements
DEFINE VALIDATION AND VERIFICATION REQUIREMENTS
• For each work package define:
1. Items to be validated and verified
2. Sequence of validation and verification
3. Personnel participation
A. Writer
B. Quality assurance
C. Design engineer
D. Customer
E. User
4. Specifications and standards involved
5. Time requirements for validation and verification
6. Methods of validation and verification performance
7. Equipment availability requirements
• For total equipment/system MOTD integration define:
1. Subcontractor MOTD to be validated and Verification
2. Equipment vendor MOTD to be validated and verified
3. Items 2 thru 7 above
Time and Equipment Availability Requirements
Validation and Verification Requirements
Based on requirements, generate validation and verification plan for in-house, subcontractor and equipment vendor developed MOTD
MOTD Validation/ Verification Plan
To Customer for Review and Approval

2

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SYSTEMS AND FEASIBILITY TRADEOFF ANALYSES. TASK 1. ANALYSIS OF --ETC(U)
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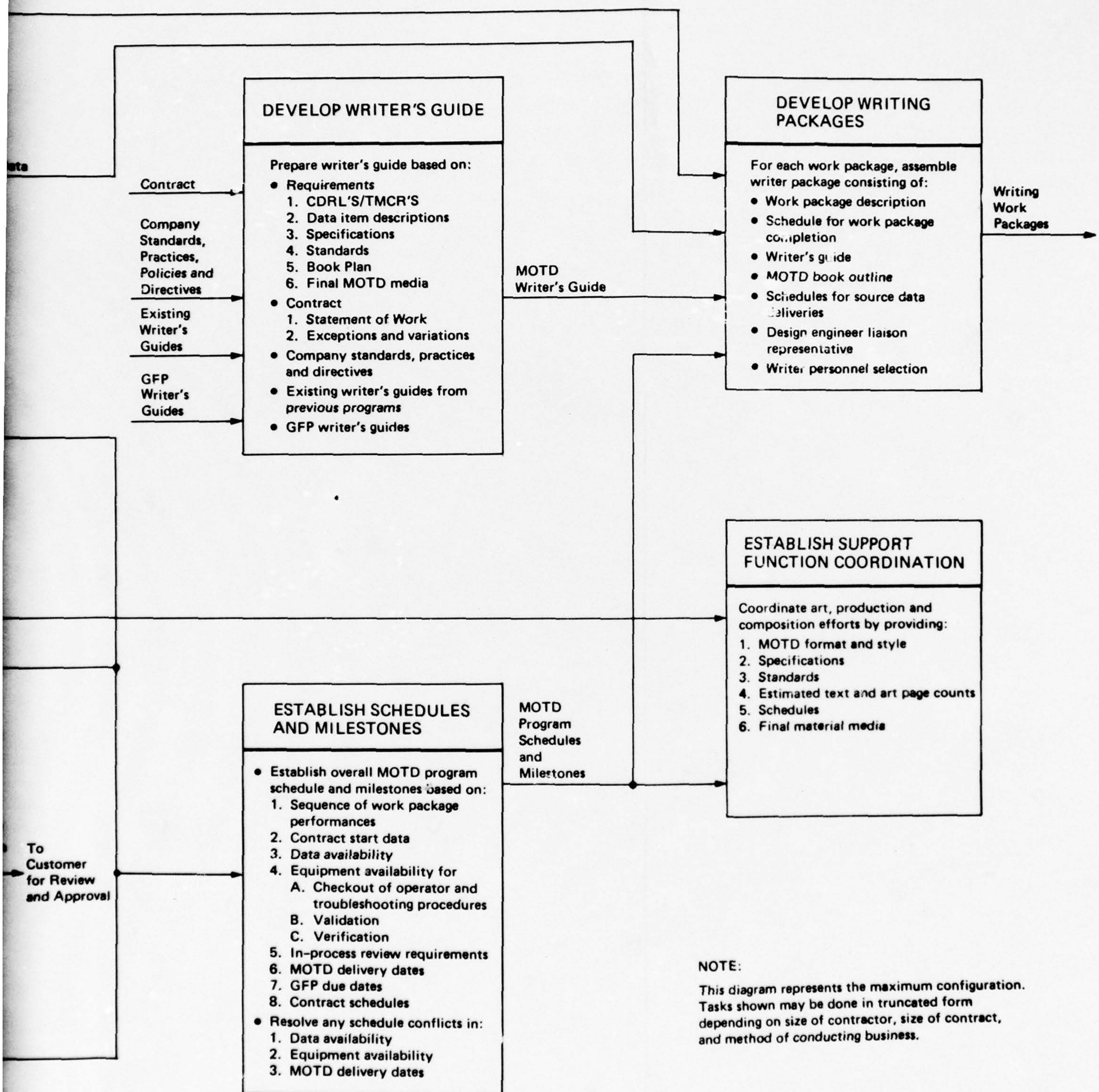


Figure 3-18. Writing Tasks, Technical Manual Planning Phase. A higher degree of coordination is needed between the writing activity and engineering, training, and quality assurance organizations.

3.3.1.6 WRITING TASKS FOR THE TM DEVELOPMENT PHASE

The military contractor is driven primarily by cost factors rather than MOTD quality considerations. To offset this factor, reviewing agencies must develop analytical measures of MOTD quality.

The TM development phase (Figure 3-19) constitutes the largest time period in the contractor MOTD production process. This is the initial point at which the TM writer becomes involved in MOTD development process. All previous preparatory efforts performed by TM supervisory personnel are for the purpose of expediting and enhancing the function of the TM writer. During this phase, previously developed writing work packages are used to generate draft MOTD, which is reviewed by cognizant TM supervisory and contractor quality control personnel. The reviewed draft MOTD is then routed through the composition, art, and production activities, resulting in the deliverable MOTD manuscript. After customer review, the contractor incorporates comments, verification takes place, and the final MOTD product is delivered to the customer.

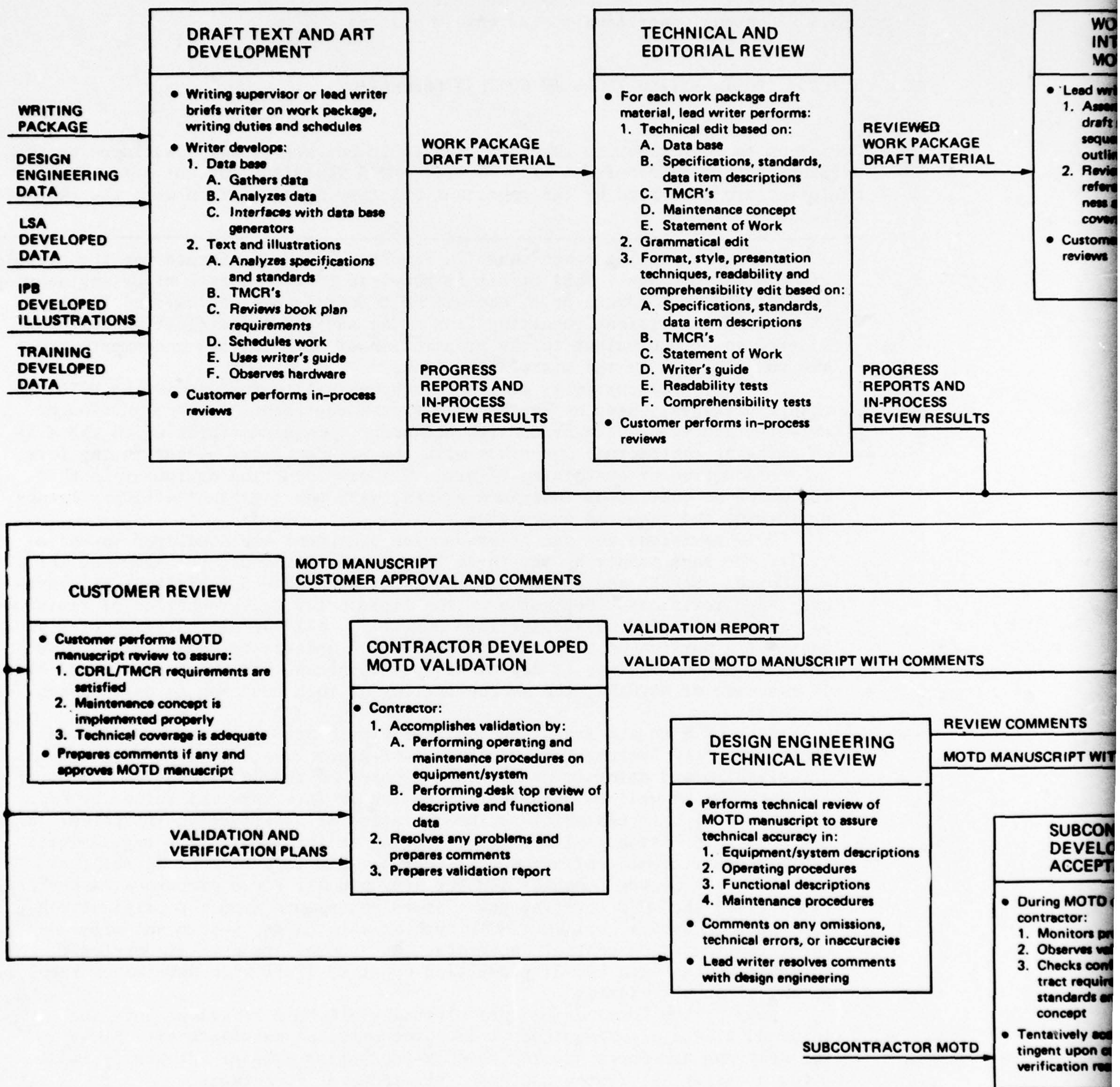
A major problem during the TM development phase is content generator access to hardware. The generation of accurate removal and replacement, maintenance, and troubleshooting procedures, as well as validation of these procedures, cannot be accomplished properly without timely access to the hardware. However, MOTD hardware requirements are usually assigned a low priority when competing with entities such as acceptance testing, quality assurance, and reliability testing. Without the benefit of contractual guidelines in this area, the content generator is often forced to develop what amount to "theoretical" maintenance and troubleshooting procedures which are never validated.

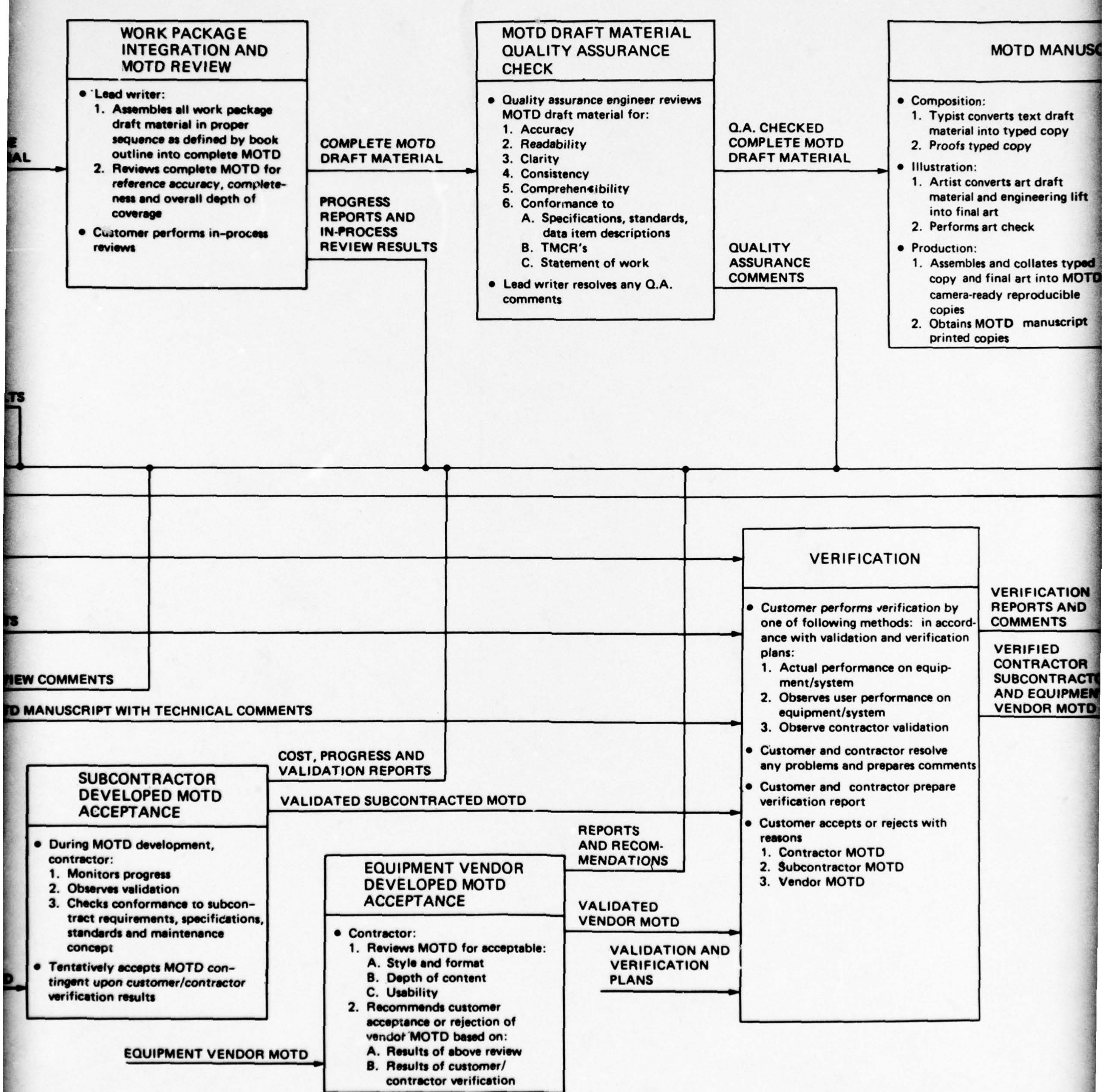
User surveys have determined that critical MOTD deficiencies exist in the areas of system-level coverage and subsystem/equipment interfaces. Equipment manufacturers frequently have little or no data on interfaces between their equipment and the remainder of the system. As a result, these interfaces receive sketchy TM coverage at best. Often, system manuals are no more than a compilation of interface diagrams and provide no data on overall system or subsystem maintenance and troubleshooting. Citable cases also exist where "system cognizance" has not been designated, and the maintenance technician is forced to troubleshoot using a conglomeration of individual equipment manuals.

At various stages in the TM development phase, contractor in-process reviews are conducted by the reviewing agency. During these reviews, problems in MOTD development are uncovered, many of which are unique to the systems/equipments in question. The governing factor in resolving these problems is conformance to the MOTD specifications. TM content specifications now in use are generally based upon a categorical approach to system or equipment functions, and cover an entire family of systems or equipment types. This categorical structure does not account for the exact functional needs of the

specific system and its specific user. Since the customer in-process review team usually has no representative of the using community, no consideration is given to alternatives which (while not adhering to the letter of the specification) provide more effective user-data and equipment-data matches.

A key factor in developing effective MOTD is technical accuracy. High levels of technical accuracy have a severe impact on contractor costs. As a result, contractors frequently take a calculated risk on underfunded programs and submit MOTD with a low confidence factor from an accuracy viewpoint. The underlying premise is that only minimal rework will be required, based on sheer volume of data to be reviewed and/or lack of technical awareness on the part of the reviewer.


WRITING PACKAGE
DESIGN ENGINEERING DATA
LSA DEVELOPED DATA
IPB DEVELOPED ILLUSTRATIONS
TRAINING DEVELOPED DATA
DRAFT TEXT AND ART DEVELOPMENT
• Writing supervisor or lead writer briefs writer on work package, writing duties and schedules
• Writer develops:
1. Data base
A. Gathers data
B. Analyzes data
C. Interfaces with data base generators
2. Text and illustrations
A. Analyzes specifications and standards
B. TMCR's
C. Reviews book plan requirements
D. Schedules work
E. Uses writer's guide
F. Observes hardware
• Customer performs in-process reviews
WORK PACKAGE DRAFT MATERIAL
PROGRESS REPORTS AND IN-PROCESS REVIEW RESULTS
TECHNICAL AND EDITORIAL REVIEW
• For each work package draft material, lead writer performs:
1. Technical edit based on:
A. Data base
B. Specifications, standards, data item descriptions
C. TMCR's
D. Maintenance concept
E. Statement of Work
2. Grammatical edit
3. Format, style, presentation techniques, readability and comprehensibility edit based on:
A. Specifications, standards, data item descriptions
B. TMCR's
C. Statement of Work
D. Writer's guide
E. Readability tests
F. Comprehensibility tests
• Customer performs in-process reviews
REVIEWED WORK PACKAGE DRAFT MATERIAL
PROGRESS REPORTS AND IN-PROCESS REVIEW RESULTS
CUSTOMER REVIEW
• Customer performs MOTD manuscript review to assure:
1. CDRL/TMCR requirements are satisfied
2. Maintenance concept is implemented properly
3. Technical coverage is adequate
• Prepares comments if any and approves MOTD manuscript
MOTD MANUSCRIPT CUSTOMER APPROVAL AND COMMENTS
CONTRACTOR DEVELOPED MOTD VALIDATION
• Contractor:
1. Accomplishes validation by:
A. Performing operating and maintenance procedures on equipment/system
B. Performing desk top review of descriptive and functional data
2. Resolves any problems and prepares comments
3. Prepares validation report
VALIDATION REPORT
VALIDATED MOTD MANUSCRIPT WITH COMMENTS
VALIDATION AND VERIFICATION PLANS
DESIGN ENGINEERING TECHNICAL REVIEW
• Performs technical review of MOTD manuscript to assure technical accuracy in:
1. Equipment/system descriptions
2. Operating procedures
3. Functional descriptions
4. Maintenance procedures
• Comments on any omissions, technical errors, or inaccuracies
• Lead writer resolves comments with design engineering
REVIEW COMMENTS
SUBCONTRACTOR MOTD


WORK PACKAGE INTEGRATION AND MOTD REVIEW
• Lead writer:
1. Assembles all work package draft material in proper sequence as defined by book outline into complete MOTD
2. Reviews complete MOTD for reference accuracy, completeness and overall depth of coverage
• Customer performs in-process reviews
COMPLETE MOTD DRAFT MATERIAL
PROGRESS REPORTS AND IN-PROCESS REVIEW RESULTS
MOTD DRAFT MATERIAL QUALITY ASSURANCE CHECK
• Quality assurance engineer reviews MOTD draft material for:
1. Accuracy
2. Readability
3. Clarity
4. Consistency
5. Comprehensibility
6. Conformance to
A. Specifications, standards, data item descriptions
B. TMCR's
C. Statement of work
• Lead writer resolves any Q.A. comments
Q.A. CHECKED COMPLETE MOTD DRAFT MATERIAL
QUALITY ASSURANCE COMMENTS
MOTD MANUSC
• Composition:
1. Typist converts text draft material into typed copy
2. Proofs typed copy
• Illustration:
1. Artist converts art draft material and engineering lift into final art
2. Performs art check
• Production:
1. Assembles and collates typed copy and final art into MOTD camera-ready reproducible copies
2. Obtains MOTD manuscript printed copies
E
IAL
TS
TS
IEW COMMENTS
D MANUSCRIPT WITH TECHNICAL COMMENTS
VERIFICATION
• Customer performs verification by one of following methods: in accordance with validation and verification plans:
1. Actual performance on equipment/system
2. Observes user performance on equipment/system
3. Observe contractor validation
• Customer and contractor resolve any problems and prepares comments
• Customer and contractor prepare verification report
• Customer accepts or rejects with reasons
1. Contractor MOTD
2. Subcontractor MOTD
3. Vendor MOTD
VERIFICATION REPORTS AND COMMENTS
VERIFIED CONTRACTOR SUBCONTRACT AND EQUIPMEN VENDOR MOTD
COST, PROGRESS AND VALIDATION REPORTS
SUBCONTRACTOR DEVELOPED MOTD ACCEPTANCE
• During MOTD development, contractor:
1. Monitors progress
2. Observes validation
3. Checks conformance to subcontract requirements, specifications, standards and maintenance concept
• Tentatively accepts MOTD contingent upon customer/contractor verification results
VALIDATED SUBCONTRACTED MOTD
REPORTS AND RECOMMENDATIONS
EQUIPMENT VENDOR DEVELOPED MOTD ACCEPTANCE
• Contractor:
1. Reviews MOTD for acceptable:
A. Style and format
B. Depth of content
C. Usability
2. Recommends customer acceptance or rejection of vendor MOTD based on:
A. Results of above review
B. Results of customer/contractor verification
VALIDATED VENDOR MOTD
VALIDATION AND VERIFICATION PLANS
D
EQUIPMENT VENDOR MOTD

MOTD MANUSCRIPT PREPARATION

Composition:
1. Typist converts text draft material into typed copy
2. Proofs typed copy

Illustration:
1. Artist converts art draft material and engineering lift into final art
2. Performs art check

Production:
1. Assembles and collates typed copy and final art into MOTD camera-ready reproducible copies
2. Obtains MOTD manuscript printed copies

- Writing:
  Lead writer resolves any composition, illustration or production problems
- Quality Assurance:
  1. Reviews MOTD camera-ready copy for accuracy and reproducibility
  2. Reviews MOTD manuscript printed copies for quality and completeness
  3. Assures MOTD manuscript printed copy deliveries are made in accordance with CDRL's/TMCR's

PROGRESS AND QUALITY ASSURANCE REPORTS

CONTRACTOR DEVELOPED MOTD MANUSCRIPT

IN–PROCESS MONITORING AND STATUS REPORTING

Writing Supervisor:
- Prepares and submits incremental cost, progress, validation and verification reports to customer
- Assures:
  1. Data base currency and availability
  2. Work package instructions, specifications, standards, TMCR, and writer's guide are being followed
  3. Schedules are being met
  4. Reviews quality assurance comments for validity
- Looks forward for possible problems in:
  1. Schedules and milestones
  2. Data base availability and currency
  3. Equipment availability
  4. In-process reviews
  5. Quality assurance
  6. Composition, art and production

COST, STATUS, VALIDATION AND VERIFICATION REPORTS

TO CUSTOMER

N

...tion by
... in accord-
...rification
... equip-
...nce on
...dation
...resolve
... comments
... prepare
...s with

VERIFICATION REPORTS AND COMMENTS

VERIFIED CONTRACTOR SUBCONTRACTOR AND EQUIPMENT VENDOR MOTD

MOTD FINAL MATERIAL PREPARATION

- Writing:
  1. Writer reviews and incorporates applicable comments into MOTD manuscript text and art
  2. Writer incorporates latest design engineering and LSA data changes
  3. Lead writer resolves any differences with customer
- Composition:
  1. Typist incorporates all text changes into typed copy
  2. Proofs typed copy
- Illustration:
  1. Artist incorporates art changes and latest engineering changes into final art
  2. Performs art check
- Production:
  1. Assembles and collates typed copy and final art into MOTD final camera-ready reproducible copy
  2. Obtains MOTD final material
- Quality Assurance:
  1. Reviews MOTD final camera-ready copy for accuracy of comment incorporation
  2. Reviews MOTD final material for completeness and quality
  3. Assures MOTD final material deliveries are made in accordance with CDRL's/TMCR's

FINAL MOTD DELIVERY

TO CUSTOMER

NOTE:
THIS DIAGRAM REPRESENTS THE MAXIMUM CONFIGURATION. TASKS SHOWN MAY BE DONE IN TRUNCATED FORM DEPENDING ON SIZE OF CONTRACTOR, SIZE OF CONTRACT AND METHOD OF CONDUCTING BUSINESS.

Figure 3-19. Writing Tasks, Technical Manual Development Phase. The strongest need in this area is the development of analytical measures of quality to detect content weaknesses arising from economic and schedule pressures.

3.3.1.7 POST-WRITING TASKS IN CONTENT GENERATION

Revisions to MOTD covering in-production equipment are usually developed by the original equipment manufacturer. However, MOTD revisions for out-of-production equipment are generated by the cognizant military agency, often with the help of data houses.

The post-writing tasks shown in Figure 3-20 are performed for the purpose of MOTD maintenance. This effort is required to incorporate minor engineering changes to the hardware or to correct MOTD deficiencies discovered in the field. MOTD revisions resulting from major equipment modifications are considered to be equivalent to the preparation of MOTD for new equipment, and are not included in the postwriting tasks.

A difference currently exists in responsibility for developing MOTD change packages, based on whether the system/equipment is in-production or out-of-production. (In-production equipment is equipment for which there is an existing contractual interface with the manufacturer, either in the form of a production or sustaining effort. Out-of-production equipment is that for which no contractor interface exists, with the cognizant military agency performing the required sustaining.)

MOTD revisions for out-of-production equipment are developed in essentially the same manner by the three Navy System Commands, the Army and the Air Force. NAVSEA and NAVAIR use their cognizant field activities to generate these revisions. Depending on the field activity, production of revisions is either automated or accomplished manually. All the military agencies subcontract a portion of their out-of-production updates to data houses. The level of subcontracting is dependent upon cognizant field activity staff size. In the case of NAVELEX, the subcontracting of this function to data houses is total.

Lack of adequate funds and configuration control are the key problems facing the Navy Systems Commands in out-of-production equipment MOTD updates. Establishing and maintaining accurate records on the configuration status of all Navy TMs as well as data indicating the TM inventory maintained by each field activity, is essential to the operation of an effective TM system. Without this information, neither the procuring activity nor the using activity can have sufficient confidence that current MOTD is available in the field.

The Navy System Commands and the Army and Air Force procure a vast majority of the MOTD covering new systems/equipments from the original manufacturer. However, original MOTD such as work cards, system and site manuals, configuration control documents, and indexes are usually developed internally. As with out-of-production updates, staff size determines the extent of subcontracting.

Navy System Commands procure virtually all MOTD revisions covering in-production systems/equipments from the original manufacturer. However, the Army and Air Force develop some in-production updates internally, while using the original system/equipment manufacturer for others.

The Navy System Commands face a common dilemma when dealing with MOTD updates covering identical systems/equipments purchased by more than one command. Lack of coordination by the cognizant system commands sometimes leads to dual procurement of in-production MOTD revisions from the original equipment manufacturer, resulting in a double expenditure of funds for essentially the same effort.

Programs on which periodic change efforts are procured (as opposed to on-going sustaining) create problems for the contractor. System/equipment technical expertise as well as familiarity with MOTD requirements built up during the period of original MOTD generation is diluted when the cognizant writing group is disbanded. Additionally, the funds allotted for change efforts do not allow for an extensive learning cycle on the part of new personnel selected exclusively on the basis of availability. As a result, change packages deployed in the field are frequently technically inadequate and fail to correspond to the original technical manual from the standpoint of format and presentation approaches.

MOTD MAINTENANCE

- Perform post writing tasks to:
  1. Maintain MOTD current on continuing basis by contracted sustain-in effort
  2. Maintain MOTD current on incremental basis as need arises by individual contracts

DESIGN ENGINEERING CHANGES

BASIC MOTD

MONITOR AND RESPOND TO DATA BASE CHANGES AND ADDITIONS

- Accumulates design engineering change data
  1. Revised engineering drawings
  2. Engineering change proposals (ECP's)
  3. Engineering orders (EO's)
- Analyze design engineering change data for impact on MOTD
- Estimate size of and effort required to develop MOTD change package
- Notify customer that requirement exists for MOTD change
  1. Reason
  2. Estimated size of MOTD change and provide:
  3. Estimated level of effort required to develop MOTD change
- Negotiate contract for development of MOTD change (Note: Individual contracts are not required if sustaining effort is in effect unless change is beyond scope of sustaining effort)

MOTD CHANGE REQUIREMENTS

CUSTOMER COMMENTS

USER COMMENTS

REVIEW AND RESPOND TO CUSTOMER AND USER COMMENTS

- Review comments for:
  1. Technical error
  2. Grammatical error
  3. Operator or maintenance personnel preference
  4. Safety hazard
  5. Not related to MOTD
- Analyze comments for:
  1. Accuracy
  2. Applicability
  3. Usability
  4. Cost of implementation
- Propose action to be taken:
  1. Incorporate comment as is
  2. Incorporate comment with modifications
  3. Initiate investigation
  4. No action to be taken and reason why
- Respond to comment initiator promptly with:
  1. Date comment received
  2. Action to be taken
  3. Date action to be implemented
  4. Recomendations

VIEW AND RESPOND
CUSTOMER AND
ER COMMENTS

w comments for:
chnical error
rammatical error
perator or maintenance per-
nnel preference
fety hazard
ot related to MOTD

yze comments for:
curacy
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corporate comment as is
corporate comment with
odifications
itiate investigation
action to be taken and reason
hy

ond to comment initiator
ptly with:
ate comment received
ction to be taken
ate action to be implemented
ecomendations

MOTD CHANGE REQUIREMENTS

RESPONSE

COMMENT INITIATOR

PREPARE MOTD CHANGE PACKAGE

- Writer:
  1. Prepares schedule for developing, validating, verifying and delivering MOTD change package
  2. Coordinates activities with composition, art, production and quality assurance
  3. Contacts design engineering if necessary to resolve problem
  4. Prepares input consisting of marked up draft text and art reflecting equipment change or modification
- Composition, art and production personnel:
  1. Updates or adds new material to basic text and art camera-ready reproducable copy as indicated by writer input
  2. Assembles change package camera-ready reproducable copy
  3. Obtains MOTD change package manuscript copies
- Quality assurance engineer:
  1. Reviews marked up text and art for accuracy and conformity to basic MOTD format and style
  2. Review change package camera-ready reproducable copy for accuracy of change data incorporation and legability
  3. Reviews MOTD change package manuscript printed copy

MOTD CHANGE PACKAGE MANUSCRIPT

CUSTOMER REVI
VALIDATION AN
VERIFICATION

- Customer:
  1. Reviews MOTD change
     manuscript for conform
     TMCR, DID, specificatio
     standards, format and st
     basic MOTD
  2. Determines need for va
     and/or verification
  3. Schedules on-site equip
     availability, establishes
     tomer, user and contrac
     personnel requirements
     assures support equipm
     availability if validation
     verification are required
  4. Monitors validation and
     verification and resolve
     MOTD change package
     with contractor and ap
- Writer performs validat
  participates in verificati
  if required by customer
- Quality assurance monitor
  tion and/or verification an
  ments any discrepancies

Figu
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2

CUSTOMER REVIEW, VALIDATION AND VERIFICATION

- Customer:
  1. Reviews MOTD change package manuscript for conformance to TMCR, DID, specifications, standards, format and style of basic MOTD
  2. Determines need for validation and/or verification
  3. Schedules on-site equipment availability, establishes customer, user and contractor personnel requirements and assures support equipment availability if validation and/or verification are required
  4. Monitors validation and performs verification and resolves any MOTD change package problems with contractor and approves
- Writer performs validation and participates in verification effort if required by customer
- Quality assurance monitors validation and/or verification and documents any discrepancies

VALIDATED AND/ OR VERIFIED MOTD CHANGE PACKAGE MANUSCRIPT

PREPARE MOTD CHANGE PACKAGE FINAL MATERIAL

- Writer:
  1. Reviews approved MOTD change package manuscript and any comments
  2. Resolves any differences with customer
  3. Prepares final MOTD change package text and art input
- Composition, art and production personnel
  1. Updates MOTD change package text and art camera-ready reproducable copy as indicated by writer input
  2. Assembles final change package camera-ready reproducable copy
  3. Obtains final MOTD change package copies
  4. Delivers final MOTD change package to customer
- Quality assurance engineer:
  1. Reviews final MOTD change package writer input for incorporation of approved validation and/or verification comments
  2. Reviews final change package camera-ready reproducable copy
  3. Reviews MOTD change package final material printed copy
  4. Assures MOTD change package final material is delivered in accordance with contract requirements

FINAL MOTD CHANGE PACKAGE MATERIAL

NOTE:
THIS DIAGRAM REPRESENTS THE MAXIMUM CONFIGURATION. TASKS MAY BE DONE IN TRUNCATED FORM DEPENDING ON SIZE OF CONTRACTOR, SIZE OF CONTRACT, AND METHOD OF CONDUCTING BUSINESS.

Figure 3-20. Postwriting Tasks. MOTD maintenance is performed to ensure that current TMs reflect the current system equipment configuration.

3.3.1.8 TECHNICAL MANUAL PRESENTATION TECHNIQUES HANDBOOKS

The objective of TM Presentation Techniques Handbooks is to influence MOTD content by describing how to develop material using the selected presentation technique. A major deficiency in such handbooks at present is that while a description of the final product is provided, insufficient emphasis is placed on detailing the processes required to produce that product.

A survey of current TM Presentation Techniques Handbooks revealed that an insufficient number of these documents exist. As a result, TM writers must often look to portions of the MOTD content specifications which deal with the planning and production of specific presentation techniques in an attempt to fill the void. Therefore, this topic details an analysis both of existing TM Presentation Techniques Handbooks and applicable areas in the MOTD content specifications.

Four TM presentation techniques are presently used by the military services - the traditional text-oriented type, Functionally Oriented Maintenance Manuals (FOMM), Job Performance Aids (JPA), and the Work Package (WP) concept. Despite the increasing use of new TM presentation techniques, the most prevalent form is still the traditional. (See Table 3-XVIII.)

The NAVSEA and NAVELEX System Commands use a combination of the traditional and FOMM. NAVAIR System Commands procurements have implemented almost exclusive use of Work Packages. The Air Force and Army rely on a combination of JPA and the traditional approach. Both FOMM and JPA have severe limitations when applied to digital equipment. The Work Package concept is limited mainly by the lack of a writers' guide to supplement corresponding military specifications MIL-M-81927/81928/81929.

Military specification MIL-M-24100B provides guidelines for the planning and production of FOMMs. Normally, a FOMM comprises two volumes, divided into multiple sections. Volume 1 - Support, contains the general characteristics and operational capabilities of the equipment, the operation instructions, the theory of operation, scheduled maintenance, installation instructions, testing procedures, and a parts list. Volume 2 - Troubleshooting/Repair (T/R), contains a family tree equipment breakdown, a pictorial interconnecting cabling/piping diagram, a turnon/checkout chart, an overall function diagram with keyed text and maintenance dependence chart (MDC), blocked schematics with keyed text and MDCs, repair/alignment procedures, parts data and wiring diagrams. FOMMs provide information to the level of detail sufficient to show the smallest functional entity. Additionally, a Technicians Pocket Manual (which is a photo reduction of the T/R Volume) may be procured.

Two of the more salient features of FOMM are the use of color coding to show the hierarchical functional or hardware level a drawing contains, and the use of MDCs. The MDC contains the data necessary to isolate a fault to a single cause by the use of checkpoint sequence and signal information.

The major drawbacks of FOMM are its relative inapplicability to digital equipment and, though FOMM drawings are formatted for microform, the color-coding has a significant cost impact on the reproduction process.

Although FOMM was originally developed for use with analog equipment, its use is currently being expanded into the digital area. However, MIL-HDBK-242 (the FOMM writers' guide) does not address modifications to this technique required for its adaptation to the digital world. FOMM-type diagrams which depict equipment signal flow are not particularly effective when dealing with equipment where feedback loops, logic levels and timing are the most critical parameters.

The Air Force Human Resources Laboratories' AFHRL-TR-73-43 is the Air Force handbook for use with MIL-J-83302 in the preparation of JPAs. The two major types of JPAs are Fully Proceduralized Troubleshooting Aids (FPTA) and Job Guides.

FPTAs are action tree diagrams with step-by-step Checkout Procedures. An action tree diagram shows the technician the sequence of steps to take to identify a malfunctioning component. JPAs require an action tree for each possible malfunction of the equipment. The Checkout Procedures are prepared to link all the action trees together by use of Test Decision Boxes, Procedural Boxes, and Repair/Replace Boxes.

JPA Job Guides are illustrated step-by-step instructions for the performance of all organizational maintenance except troubleshooting. The Inspection Guideline Manual contains all routine inspection job guides while all other job guide maintenance functions are provided in the Maintenance Information Manual. A Maintenance Support Information Manual supplements the Job Guide with data that is adaptable to Job Guide format.

Neither MIL-J-83302 or AFHRL-TR-73-43 provides adequate instructions on the development of JPAs for electronic equipment. The primary focus of these documents is on mechanical hardware where malfunctioning parts can be observed by visual inspection. The more abstract problem of troubleshooting electronic hardware, where a faulty part is not directly observable, has been largely ignored.

Compared to mechanical systems, electronic troubleshooting involves many factors other than simple tools and visual observations. The setup of test equipment, measurement and interpretation of both quantitative and qualitative parameters, and the requirement for functional as well as spatial orientation greatly complicate the fault isolation process. The complex interplay of these factors requires development procedures not found in the existing JPA specification or writers' guide.

AF-PAMPHLET 13-2 (Air Force), NWC Ad Pub 157 (Naval Weapon Center - NAVSEA), Defense Mapping Agency Aerospace Center (DMAAC-Air Force) RP-75-002, Army Nuclear Defense Laboratory NDL-SP-20 are all editorial style guides that reflect very general guidelines for the production of TMs and technical reports, but do not address specific presentation techniques.

At present, the Army is using the traditional presentation technique without a handbook to supplement MIL-M-63000 or MIL-M-38784A specifications. The NAVAIR System Command's use of the Work Package technique depends exclusively on MIL-M-81927/81928/81929 without a supplementary style guide.

Section 3 - Data Collection and Analysis
3.3 - Research Issue 3: Content Generation
3.3.1 - Content Generation in Current TM Systems

TABLE 3-XVIII. CURRENT TM PRESENTATION TECHNIQUE HANDBOOKS

	Traditional	FOMM	Work Package	JPA	Writers' Handbook	Military Specification
NAVSEA	X	X	-	-	MIL-HDBK-242 Functionally Oriented Maintenance Manual 1974	MIL-M-24100B MIL-M-38784A
NAVELEX	X	X	-	-	MIL-HDBK-242 Functionally Oriented Maintenance Manual 1974	MIL-M-24100B MIL-M-38784A
NAVAIR	-	-	X	-	-	MIL-M-81927/81928/81929
Army	X	-	-	-	-	MIL-M-38784A MIL-M-63000
Air Force	X	-	-	X	AF Pamphlet 13-2 1973 AFHRL-TR-73-43 1973 Job Performance Aids	MIL-M-38784A MIL-J-83302
NWC	X	-	-	-	NWC Ad Pub 157 1974 Editorial Style Guide	-
DMAAC	X	-	-	-	RP-75-002 1975 The Production of Technical Publications	-
US Army Nuclear Defense Laboratories	X	-	-	-	NDL-SP-20 1967 A Guide for the Preparation of USANDL P	-

3.3.1.9 WRITERS' GUIDES FOR READABILITY AND COMPREHENSIBILITY

Despite the existence of general guidelines and measurement formulas, there is currently a lack of practical tools such as vocabulary controls and writers' training courses which would enable the technical writer to prepare TMs with readability and comprehensibility as a major goal.

Readability and comprehensibility guidelines and measurement formulas are provided in the various MOTD content specifications and writers' guides. (See Table 3-XIX.)

The only guidelines of MIL-M-38784A (all services), MIL-J-83302 (Air Force) MIL-M-81927 (NAVAIR) and MIL-M-24100B (NAVSEA, NAVELEX), which could be construed as affecting readability/comprehensibility, are contained in the writing style instruction portions of these specifications. They are all similar and in general state the following rules of writing:

1. No vague or ambiguous terms
2. Use simplest words and phrases
3. Include all essential information
4. Use consistent terminology
5. Use consistent organization
6. Keep sentences short and concise
7. Use punctuation sparingly and properly

Portions of MIL-M-38784A (which detail Army unique requirements) and MIL-M-63000 provide the Army with significantly more explicit guidelines for readability/comprehensibility. There are three standards by which Army TM writing is evaluated:

Standard No. 1 - Average Sentence Length (ASL)
- A. 20 words maximum.
- B. 1 to 17 words desirable.
- C. 18 to 20 words acceptable.

Standard No. 2 - Average Word Length (AWL)
- A. 1.60 syllables maximum.
- B. 1 to 1.50 syllables desirable
- C. 1.51 to 1.60 syllables acceptable

Standard No. 3 - Percent Personal Sentence (PPS)
- A. 15 percent minimum
- B. 20 percent desirable
- C. 15 percent to 19 percent acceptable

None of the services currently have explicit readability/comprehensibility guidelines for graphics. Most MOTD content specifications ignore graphics entirely, while the writers' guides caution the illustrator about drawing size and overcrowding of information.

The military writers' guides approach readability/comprehensibility in the same general terms as the specifications. These documents tend to discuss content correctness rather than writing levels or usability of information.

MIL-HDBK-242, Functionally Oriented Maintenance Manuals (FOMM), is the writers' guide which supplements MIL-M-24100B and is used by the NAVSEA and NAVELEX System Commands. The writers' guide target for technical comprehension (applied across the board to all maintenance personnel) is a ninth-grade reading level with limited technical training, while MIL-M-24100B specifies the troubleshooting/repair volume be written for a high school graduate who has completed military courses qualifying him as a technician. The writers' guide also states that as a writer, editor, or reviewer could never ascertain if the technician understands the data, it is better to use illustration and short, simple descriptive text. As a guideline, the writers' guide states that reader comprehension drops rapidly when sentence length exceeds 17 words, but not to replace two or three common words with one uncommon word to lower sentence word count.

Air Force Pamphlet 13-2, Guide For Air Force Writing, is the standard writing guide for all Air Force personnel who write or approve the writing of others. This guide tells the writer to know his subject, know who will use the material, and not to use difficult words or long sentences. The guide states that the two most important items affecting readability/comprehensibility are sentence length and word difficulty. Also, the writer should remember that a readability yardstick is not a formula to write by but is only a handy statistical tool for measuring complexity of writing.

AFHRL-TR-73-43, Air Force Handbook For JPA Developers, is a handbook designed to aid the preparation of Job Performance Aids (JPA). The handbook recommends the JPA developer obtain a technician usability profile through a study of service records, interviewing technicians and their supervisors, plus direct observation of technicians at work. It suggests that the JPA developer grade each person chosen according to the following parameters and then decide the level of writing.

- Aptitude profile
- Reading level
- Intelligence
- Time in service
- Prior military training
- Prior military work assignments

The Naval Weapons Center Editorial Style Guide (NWC Ad Pub 157) is a style guide for editors, writers and compositors of scientific and technical reports. Comprehensibility instructions are to make the material clear, concise and in the proper format.

The Army and NAVAIR System Commands have preliminary writers' handbooks and style guides pending approval and distribution. NAVAIR 00-25-700 (preliminary) has very explicit readability and comprehensibility provisions for both graphics and text. A detailed discussion of this document appears in Topic 8 of the next subsection. The Army's MIL-HDBK 63038 (draft) refers back to MIL-M-38784A for readability and has some explicit comprehensibility guidelines for graphics.

The NSA preliminary writers' guide for Diagram Oriented Documentation System (DIODS) proposes the use of drawings over text to improve comprehensibility, but does not impose any explicit readability criteria for text.

3.3.1.9 WRITERS' GUIDES FOR READABILITY AND COMPREHENSIBILITY (Continued)

Commercial writers guides developed by contractors for general or specific program use tend to be very similar to military writers' guides. Readability/comprehensibility are covered in the same generalized term used in most military writers' guides.

The chief readability problem involving current Navy TMs is the mismatch between the reading grade level (RGL) of those TMs and the reading ability of the average Navy technician (determined by R. P. Carver[1] to be that of a ninth grader). Curran, Thomas, and Duffy[2] make recommendations dealing with variables affecting comprehension, evaluation and implementation of the best possible readability measurement formulas, effective procedures for guiding technical writers, and computerized feedback to writers. A review of the literature reveals that many similar studies of TM readability and the development of various measurement formulas have been conducted. All agree that writers need comprehensive training, detailed style guides, vocabulary tools, and manual and automated checks of readability of in-process and completed draft TMs. In addition, criteria and guidelines must be developed for the use and preparation of graphics in TMs. This effort must detail both when to use graphics and what type to use. Second, quality assurance guidelines are required to assess the comprehension potential of graphics. Finally, while most existing readability formulas such as the USAF Fog Count, the Flesch Reading Ease Score, and the Gunning Fog Index provide reasonable measures of readability, they do not consider comprehensibility. Textual material may be easily readable and yet be incomprehensible to the reader. The required readability/comprehensibility guidelines for text and graphics do not exist in the current Navy writers' guides and MOTD content specifications.

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[1] Carver, R. P., "Measuring The Reading Ability Levels," Personnel and Training Research Programs Psychological Sciences Division Office of Naval Research Department of the Navy, October 1973

[2] Curran, T.E., Thomas, G. I., Duffy, T. M., "Review of Technical Manual Readability and Comprehensibility," Naval Personnel Research and Development Center, July 1975

TABLE 3-XIX. CURRENT WRITERS' GUIDES FOR READABILITY/COMPREHENSIBILITY

	MOTD Content Specifications						
	Detailed Guidelines		General Guidelines				
Military Agency	MIL M38784A	MIL. M63000	MIL M81927/ 81928/ 81929	MIL M24100	MIL M38784A	MIL J83302	Military Writers' Guides
NAVSEA				X	X		MIL-HDBK-242 Functionally Oriented Maintenance Manual (FOMM)
NAVELEX				X	X		MIL-HDBK-242 Functionally Oriented Maintenance Manual (FOMM)
NAVAIR			X				Preliminary - NAVAIR 00-25-700 Technical Manual Preparation Guide for Technical Writers, Editors, and Illustrators
Army	X	X					Preliminary - MIL-HDBK-63038 Technical Manual Writing - Handbook, Style Guide
Air Force					X	X	Air Force Pamphlet 13-2 Guide for Air Force Writing AFHRL-TR-73-43. Handbook for JPA Developers
Defense Mapping Agency Aero-space Center (DMAAC)					X		The Preparation of Technical Publications
Naval Weapons Center (NWC) National Security Agency (NSA)					X		NWC Ad Pub 157 Editorial Style Guide Preliminary: Diagram Oriented Documentation System Guide (DIODS)

3.3.2.1 PROPOSED TECHNIQUES AND TRENDS IN DATA BASES

Emerging technologies in data base development will provide a more immediate and direct interface between the content generator and the data base, by eliminating the present manual base generation techniques, control requirements and distribution networks.

Present-day technology, in the use of computers and their peripheral equipments, provides an ideal way for the manufacturer to reduce his costs and improve his product by reducing or eliminating many repetitive, time-consuming tasks now required in the manual development of data bases. An analysis of various proposed systems yielded the composite data base development scheme shown in Figure 3-21. This proposed data base generation system consists of a computer, interactive graphic terminals, and output devices for developing and maintaining an automated data base. This system is adaptable to the design, development and production of all types of system, equipment and hardware products. The components and programs required to assemble this system are available today. In fact, many of the airframe and major electronic manufacturers have implemented some form of this automated data base system in their development and manufacturing processes.[1]

In this type of a system, the design engineer develops his design directly on an interactive graphic terminal resulting in all engineering drawings, specifications and test data being processed and stored in the computer. Output devices convert the computer data to the forms that manufacturing requires (numeric controlled punch tapes, planning documents, drawings, etc.) to prouce and test the system, equipment or hardware product and the forms required to meet the contract data requirements. A great many time-consuming tasks in the preparation, reproduction and distribution of a manually generated data base, as well as the accompanying human errors and controls required to reduce human errors, are eliminated. The automated system is much less error-prone because it is under machine control. Any errors in the data base can be readily corrected by the design engineer using interactive graphic terminals. To the content generator, the automated data base would provide rapid access through interactive graphic terminals eliminating the time delays associated with the manually generated and distributed data base. The elimination of the time delay also increases the data base accuracy as far as the content generator is concerned because the data he sees is the data the designer is entering into the system. Validity of the data base is maintained because the

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[1]Hughes Aircraft Co.	Automated Drafting and Manufacturing (ADAM)
Hughes Aircraft Co.	Joint Automated Wirewrap System (JAWS)
Lockheed-California Co.	Computer-Graphics Augmented Design and Manufacturing (CADAM)
Computervision Corp.	The Designer System
Vector General, Inc.	Interactive Graphics Display
Tektronix, Inc.	4081 Interactive Graphics System

computer program will grant permission for an update only to authorized design engineering personnel. However, the proposed automated data base would still be of limited use in content generation in that it is still developed for manufacturing purposes and does not contain the maintenance oriented data necessary for the development of MOTD.

Many of the factors which limit the use of the engineering/manufacturing data bases in MOTD development are cited in the REM Company task reports[1]. The data base is oriented to the manufacturing process, has accuracy problems due to incremental drawing release and a slow response time in the update cycle, and its release schedule is based upon hardware development.

The REM reports recommend that MIL-D-1000 and other specifications impacting engineering/manufacturing data require the inclusion of maintenance tolerances along with the manufacturing tolerances that customarily appear on these drawings. In addition to the REM recommendation, additional maintenance data such as lubrication, flow rates, alignment frequencies, pressures, bolt torque, bandwidth, etc. should be included as part of the engineering drawing requirements. The increased data base content would result in a reduction in MOTD development time while increasing MOTD accuracy.

A second recommendation to improve the engineering/manufacturing data bases put forth by REM is to change MIL-D-1000, MIL-STD-100 and microfilming instructions to implement a single drawing for multiple use concept. Drawings prepared under this concept would meet all users' needs, i.e., for manufacturing, direct inclusion in MOTD and as deliverable CDRL/TMCR data items. This would effect cost savings by reducing the number of drawings required to satisfy the various data requirements for a single item, and at the same time reduce development and production time for both hardware and MOTD.

Automation of the engineering data base is another recommendation supported by the REM reports. Automation as described above would ease the problems of developing and maintaining the accuracy and currency of the data base, and would provide rapid access by a user.

While these recommendations are theoretically sound and would effect the desired data base improvements, there is no indication that these suggestions will be implemented by the military. The reason appears to be a lack of quantified data verifying that a payoff in the form of decreased equipment support life cycle costs can be achieved.

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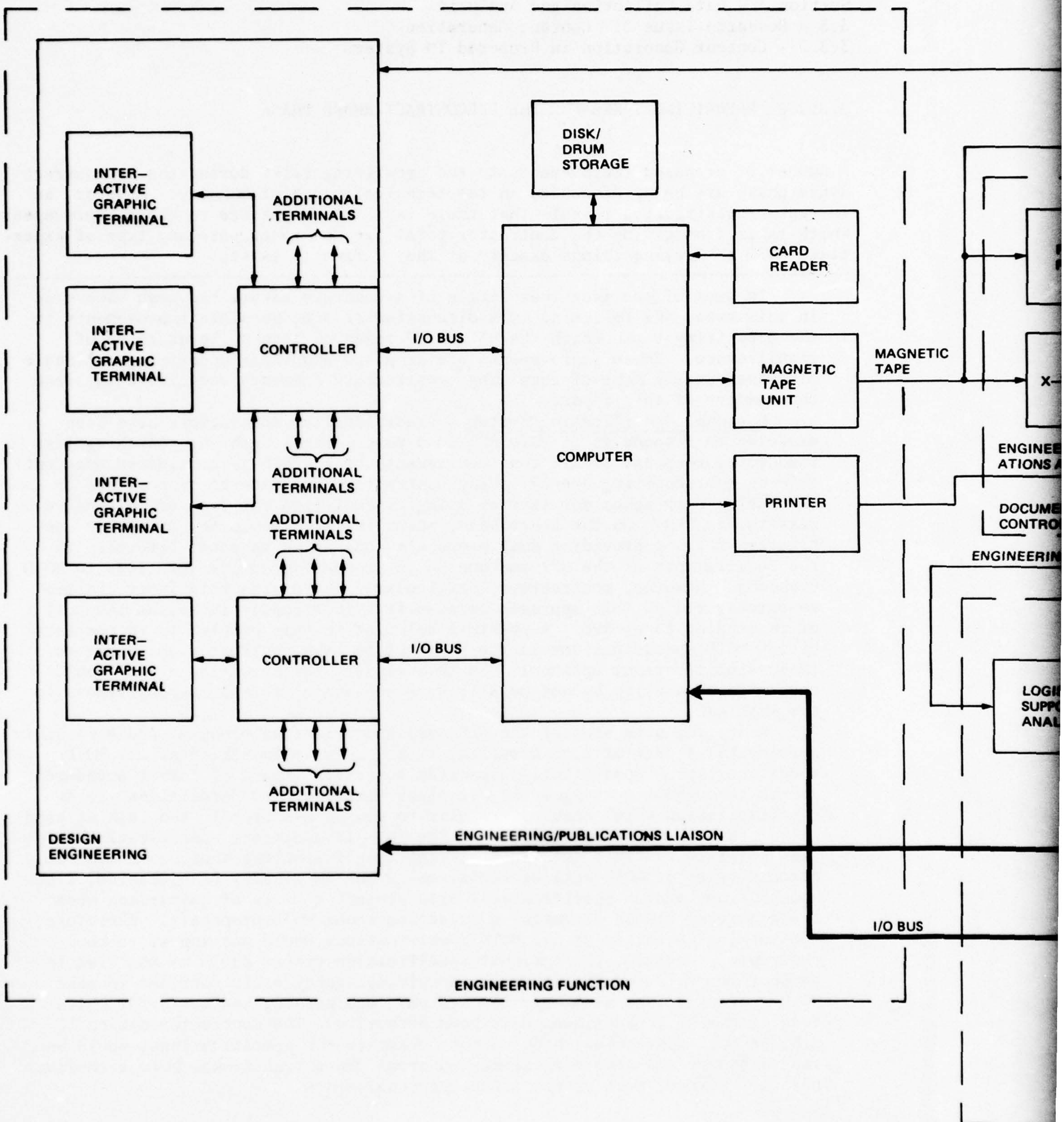
[1] Martin, A. C., Johnson, F., Meyer, W. J.; "A Critical Evaluation of the Technical Data Development Processes for the Preparation of Technical Manuals and Training for Maintenance, Task 1-4 Reports," REM Company, 1975.



INTER-ACTIVE GRAPHIC TERMINAL
ADDITIONAL TERMINALS
DISK/DRUM STORAGE
CARD READER
INTER-ACTIVE GRAPHIC TERMINAL
CONTROLLER
I/O BUS
MAGNETIC TAPE UNIT
MAGNETIC TAPE
ADDITIONAL TERMINALS
COMPUTER
INTER-ACTIVE GRAPHIC TERMINAL
PRINTER
ADDITIONAL TERMINALS
INTER-ACTIVE GRAPHIC TERMINAL
CONTROLLER
I/O BUS
ADDITIONAL TERMINALS
DESIGN ENGINEERING
ENGINEERING/PUBLICATIONS LIAISON
I/O BUS
ENGINEERING FUNCTION

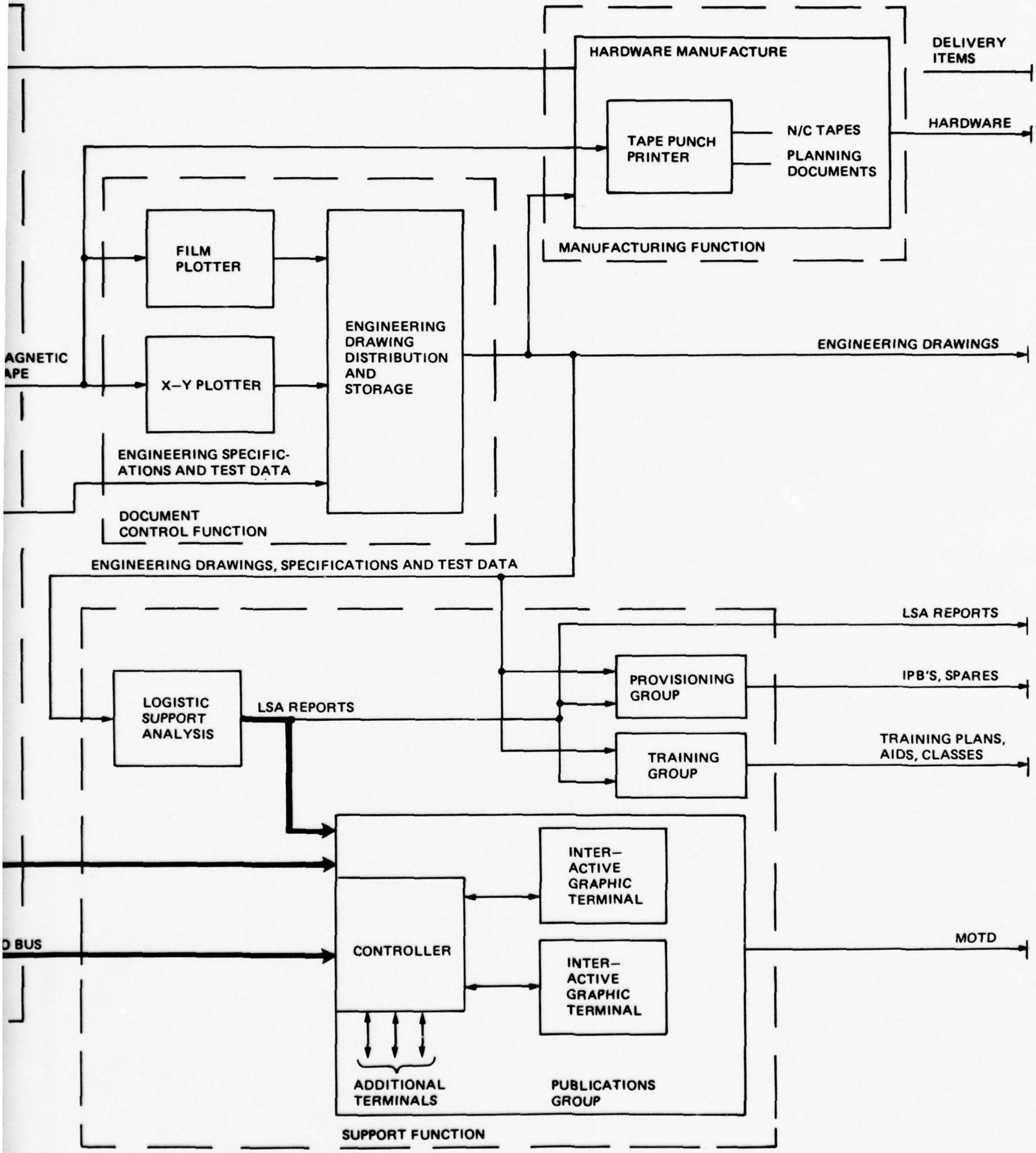


Figure 3-21. Proposed Data Base Development System

3.3.2.2 PREWRITING TASKS FOR THE PRECONTRACT AWARD PHASE

A number of proposed improvements to the prewriting tasks during the precontract award phase are being discussed in the technical manual community. However, an in-depth investigation reveals that there is little substance to these improvements which range from giving the contractor total freedom to propose any type of expertised MOTD to leaving things exactly as they currently exist.

In view of the fact that little of a concrete nature has been uncovered in this area, the following is a discussion of some possible improvements to the prewriting tasks which the HAC/NTIPP research team believes to be of significance. These improvements are proposed and their underlying rationale discussed in the hope of receiving constructive comments and criticisms from the readers of this report.

Optional Specification System - Traditionally, contractors have been expected to respond to an MOTD RFP in a most literal fashion. Anything less than total response to all the requirements of the RFP is considered unacceptable by the acquiring agency. Many contractors hesitate to propose new or innovative approaches for fear of being disqualified for lack of responsiveness to the RFP. On the other hand, acquiring agencies often criticize contractors for not providing dual proposals, one which responds literally to the requirements of the RFP and one which presents creative solutions to MOTD problems. However, contractors, particularly those with relatively limited resources, resist this approach because it significantly increases the cost of responding to an RFP. A possible solution to this problem is to continue citing MOTD specifications in the RFP, but to make contractor adherence to these specifications optional. In this manner, the acquiring agency would encourage creativity by not penalizing a contractor for nonresponsiveness to the MOTD RFP.

A logical extension of the optional specification proposal and a possibly detrimental aspect of such a system, is the total elimination of all MOTD specifications. Specifications provide a certain amount of format standardization throughout a category of technical manuals. Standardization yields familiarization which enables the user to devote his time to the task at hand rather than to locating material in the TM. In addition, specifications provide built-in controls for the acquiring agency ensuring that, as a minimum, certain types of MOTD will be contained in the TM (theory of operation, troubleshooting, etc). Specifications also present a basis of comparison when the acquiring agency is making a selection among MOTD proposals. Therefore, the total elimination of all MOTD specifications would not appear to be desirable. However, the optional specification system could be modified to account for this possibility. The acquiring agency could continue to make MOTD specifications mandatory for systems, equipments, and tasks for which traditional MOTD techniques have been effective. The contractor option to propose MOTD approaches which do not adhere to the specifications, would be restricted by the acquiring agency to areas where traditional MOTD techniques have not worked, such as new technology equipments.

TABLE 3-XX. ANALYSIS OF PROPOSED IMPROVEMENTS IN PREWRITING TASKS

Proposed Improvements	Advantages
Optional Specification System	Allows contractors to propose creative solutions to MOTD problems while not penalizing them for nonresponsiveness to RFP
Delayed MOTD Bid	Enables contractor to develop a more realistic, accurate and well defined MOTD bid based on a firm engineering design rather than an inaccurate bid based on conceptual and predesign information
MOTD Engineering Function	Assures realistic and integrated response to MOTD RFP via single entity interface with design, technical manual, training, logistic engineering, and provisioning activities

3.3.2.2 PREWRITING TASKS FOR THE PRECONTRACT AWARD PHASE (Continued)

A second possible modification to the optional specification system would retain mandatory adherence to general format specifications, but make adherence to detailed content specifications optional. Either of these modifications would allow contractors to propose creative solutions to MOTD problems which is the principal advantage of an optional specification system. However, the principal disadvantage of such a system, which is the total elimination of all MOTD specifications, would be avoided.

Delayed MOTD Proposal Approach - An additional proposed improvement in the area of prewriting tasks deals with the previously mentioned problem (Topic 3.3.1.2) of the lack of a complete and well defined engineering/manufacturing data base when the MOTD proposal is developed. In many cases, the MOTD proposal is required by the procuring activity early in the program even though the actual contractor MOTD development process is not going to begin until much later. A more reasonable approach in this type of situation would be to release the MOTD RFP at a point in time which more closely corresponds to actual MOTD development. At this stage of the program, the engineering concept is firm, hardware modifications resulting from equipment checkout and testing have been incorporated, and a large percentage of the data base is available. As a result, the content generator is now able to more realistically evaluate the task and develop an accurate MOTD proposal.

The MOTD Engineering Function - The establishment of an MOTD engineering function is a proposal which impacts all the various phases of the content generating activities (prewriting tasks, writing tasks, post-writing tasks). This proposed approach to TM content development is a modification of the System Engineering Process defined in section 10.2 of MIL-STD-499A, and the procedure for preparing maintenance instruction aids as defined in the Integrated Development of Training/Performance-Aid Requirements for Naval Air Maintenance Personnel manual prepared by Applied Science Associates, Inc. These disciplines involve requirements, functional analysis and allocation processes that would assure proper consideration of task requirements and user capabilities. The synthesis process is directed toward structuring of technical data for operator, maintenance, and training personnel.

The TM development activity will normally be a contractor; however, it may also be the SYSCOM in-house capability. The MOTD engineering function is responsible for collecting the data, preparing a detailed MOTD book plan, writing the TM, technically critiquing the TM and performing validation.

This function is built around the Program MOTD Engineer providing the proper planning and technical guidance throughout the program. He is the technical director of the MOTD program and operates in conjunction with the program's Integrated Logistic Support (ILS) manager. This approach is analogous to the conduct of hardware programs which have both a program manager operating in an administrative capacity and a technical director. The MOTD engineer is responsible for a cross fertilization between the writers and instructors, as well as ensuring that the engineering/manufacturing and logistic data base information is available. This function would perform various tradeoffs to determine the optimum presentation method, the allocation

of writer tasks, and better methods of ensuring content quality. The MOTD engineer would also be responsible for the interface with the design engineering activity for technical data. The specific functions performed by the MOTD engineer during the various phases of TM development are detailed in this and succeeding topics.

The MOTD engineer would be responsible for designing the content and usability of the technical manual. This process is started during the precontract award phase of the prewriting tasks when the MOTD engineer functioning as MOTD Proposal Technical Manager reviews the RFP. He then interfaces with the design activity to review hardware specifications, design disclosure documents, data base requirements and maintenance philosophy. Schedules and milestones are developed dealing with availability of MOTD critical items, such as portions of the deliverable and nondeliverable data base. Additionally, tentative plans are made for MOTD developer interfaces with the design activity and access to initial-delivery equipment. As proposal technical manager, the MOTD engineer is responsible for disseminating this information to MOTD developing activities consisting of technical manuals, logistics engineering, training, and provisioning. Working closely with the hardware proposal management team, the MOTD engineer then coordinates and controls the development of the MOTD proposal based on inputs from these activities, resulting in a realistic and totally integrated response to the MOTD RFP.

3.3.2.3 PREWRITING TASKS FOR THE POST-CONTRACT AWARD PHASE

Substantive proposals to improve MOTD planning documents have not been forthcoming from the technical manual community. The development of perfunctory and ineffective publication plans and MOTD book plans/outlines will continue unless innovative approaches to this process are implemented.

Time-Phasing the Development of MOTD Planning Documents - A key ingredient in MOTD planning documents is system/equipment knowledge. To tailor technical publication plans and MOTD book plans/outlines to unique system/equipment characteristics, the TM designer requires substantially firm equipment design data. This data is not available immediately after contract award, when MOTD planning documents are traditionally generated. Since actual MOTD generation does not normally begin until the hardware design process is virtually complete, a number of alternative approaches exist as to the time-phasing of MOTD design with this process. The delivery of technical publications plans and MOTD book plans/outlines could be scheduled for delivery immediately preceding the start of MOTD generation, with adequate allowance for customer review. Another alternative to the current system could be development of skeletal MOTD book plans/outlines within the normal timeframe, followed by the submission of fully detailed documents prior to MOTD generation. Finally, the possibility exists for the staged submission of partial MOTD planning documents. In this case MOTD, such as operator instructions, which is not significantly impacted by a dynamic system/equipment design, would be covered in the first submissions. Coverage of design-sensitive MOTD such as detailed theory of operation would then be developed as firm equipment design data became available. Any of these proposed improvements would be a first step toward the development of fully detailed MOTD planning documents customized to particular systems/equipments. (See Figure 3-22.)

System Conditions Approach - The proposed concept of designing technical manuals based on suggested categories of system conditions (or "warrants") as introduced in a BioTechnology Report[1] is a viable alternative to the current approach in which the only consideration is system or equipment type. Selection of presentation methods based on a consideration of additional items such as criticality, complexity, and frequency of task performance as well as maintenance environment, personnel characteristics, MOTD utilization in training, and equipment cost is essential to the development of effective MOTD. Data matched to the user, task, equipment and environment will achieve the dual goals of increased operational readiness and decreased support life cycle costs. However, the missing link in the MOTD design-to-system conditions concept is a set of guidelines which will enable the MOTD designer to accomplish his mission (matching of MOTD packages and presentation techniques to system conditions). The lack of quantifiable parameters has prohibited the use of formulas and equations in a manner analogous to their use in

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[1] Post, T. J., "System Conditions Affecting Format and Media Used to Present Maintenance Information," BioTechnology, Inc., May 1975.

equipment design. Therefore, it appears that a set of rules for MOTD development must be established which allow for objective evaluations by the content generator leading to consistent and effective MOTD designs.

MOTD Engineering Approach - After contract award, the MOTD engineer interfaces with the design activity and prepares a "first-order cut" at detailed planning, limited only by the preliminary nature of the system/equipment definitions. The resulting preliminary technical publication plans and MOTD book plans/outlines are then submitted to the reviewing agency for approval. These MOTD planning documents are then revised and expanded upon during the TM planning phase of the writing tasks when a firm system/equipment design exists.

During the postcontract award phase, the MOTD engineer is responsible for ensuring that all the engineering documentation including drawings, test specifications, wiring lists, etc., will be prepared in formats that not only meet the minimum requirements for manufacturing and test, but also are MOTD-compatible.

During this time period, the MOTD engineer will interface with the training personnel to perform a head/book tradeoff to determine the information that is to be included in the technical manual and the information that will be covered in the training program. This tradeoff will be based on the equipment, environment, task, and the user profile. Ground rules in the form of MOTD specifications will be established to provide guidance in making the tradeoff. The results will later be used in assigning writing tasks in such a way that the training program and the technical manual are compelled to complement each other.

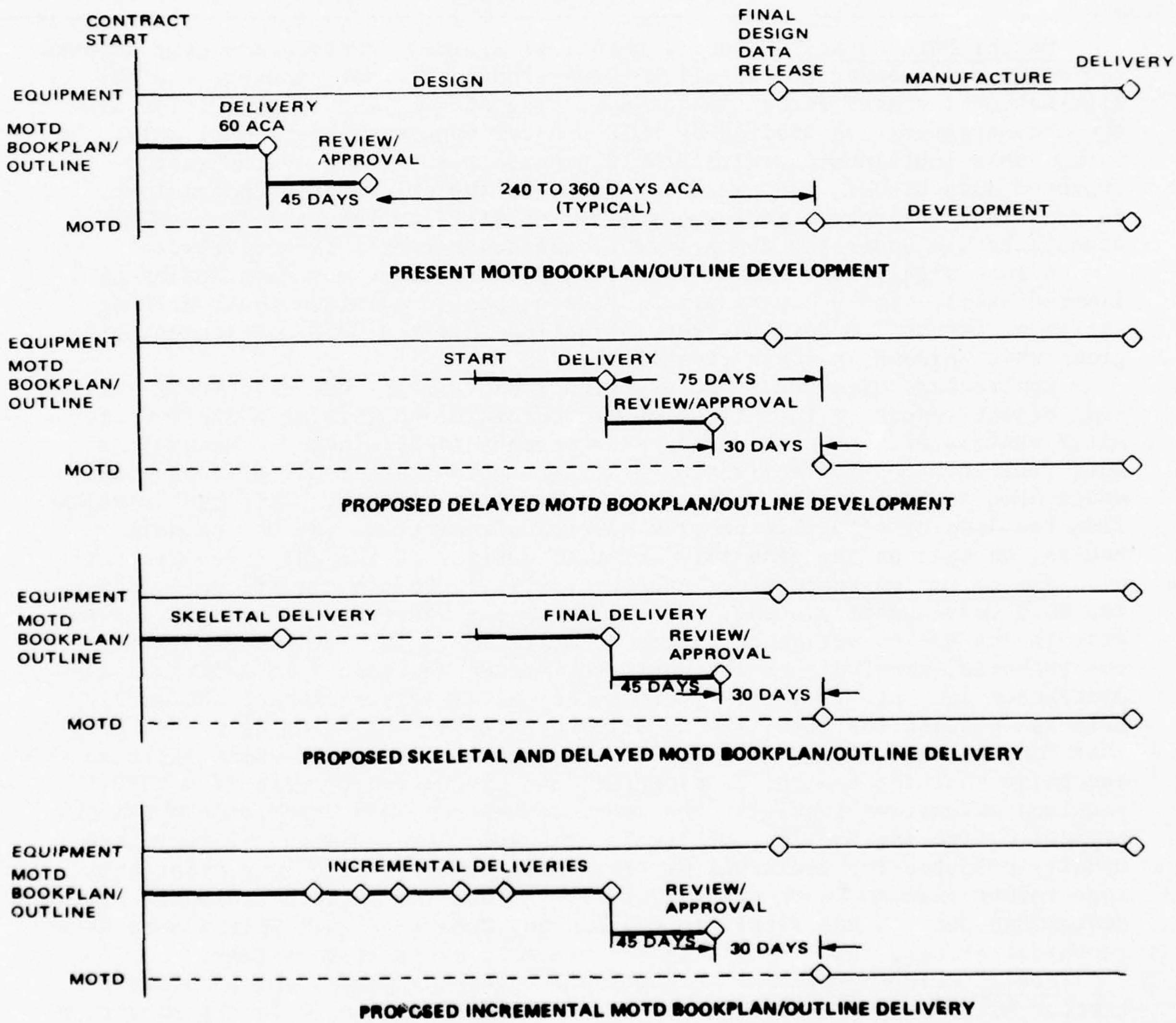

Figure 3-22. Current/Proposed Time-Phasing of MOTD Planning Document Development. Compared with the present technique, all alternatives enable the content generator to acquire more meaningful design information.

3.3.2.4 WRITING TASKS FOR THE TM PLANNING PHASE

Proposed improvements during the TM planning phase of the writing tasks range from subcontracting all MOTD development to data houses to certifying technical manual writers. To date, however, changes to the traditional contractor MOTD development process have not resulted in significant improvements to the MOTD in the field.

Use of Data Houses - A small number of military contractors have adopted the policy of subcontracting all MOTD development to data houses, thereby eliminating the need for an in-house writing staff. The TM activities at these contractors are staffed by MOTD program management personnel only. In turn, these individuals evaluate MOTD proposals submitted by contractor-approved data houses, and award contracts to the selected subcontractors. In addition, in-process reviews, validation/verification, and final MOTD acceptance are under the cognizance of the contractor's TM activity.

A more significant number of military contractors use data houses on a limited basis. These organizations have chosen to maintain their writing staffs at a constant level by subcontracting only the MOTD development programs which exceed in-house capabilities.

Contractors using data houses, either exclusively or selectively, claim cost effectiveness in that the economic burden of supporting a staff of technical writers with no work during slow periods is eliminated. However, a more realistic cost-effectiveness analysis on contractor use of data houses would have to include the cost of MOTD rewriting efforts. This cost results from the loss of effective program control attendant to the use of data houses, as well as the generally inferior quality of the delivered product.

Use of Design Engineers - Another variation to the traditional contractor MOTD development process, and one which has been adopted by many companies, is the use of design engineers to write TMs. This system capitalizes on the technical knowledge of the equipment design engineer. In addition, the contractor can opt for lower-priced technical writing personnel who merely edit and publish the TMs. The underlying premise supporting this system is that "anyone can write." This is a misconception, however, which fails to recognize that the design, development, and production of effective MOTD requires extensive linguistic knowledge, education, and experience which the typical design engineer is not likely to have. Also, design engineers are usually selected for technical writing assignments based on equipment knowledge rather than on known writing skills. Since the rated performance of the design engineer is not likely to include any measure of his performance as a technical writer, there is little incentive to excel at this task.

Use of MOTD Engineers - During the TM planning phase, the proposed contractor MOTD engineer would prepare a detailed book plan, with the support of the cognizant design engineers, that would be itemized to the page level. This book plan would detail the required content and presentation technique for each subject area and would be an extension of "design disclosure" requirements presently imposed on design engineers. To develop this detailed book plan, the MOTD engineering analysis would rely on the active participation of TM supervisors and writers, training personnel, and logistic engineering disciplines. These interfaces would be required to ensure that the

material presented in the technical manual is compatible with the training data highlighted in the classroom/laboratory sessions, and that the maintenance data reflects the engineering analysis of the tasks to be performed at the established maintenance level. The MOTD engineer would coordinate the process of data extraction from the design engineering function to ensure that all data base users are not independently interfacing with the designer. This approach would reduce the burden on the design activity while at the same time encouraging the design engineer to participate actively in the MOTD creation and validation process.

Upgrading of Technical Writers - A number of proposals have been made that would upgrade TM writers' qualifications, including: (1) Requiring certification of TM writers, (2) Requiring that TM writers be graduate engineers, and (3) Mandatory contractor-conducted TM writer training courses to include hands-on equipment experience both in-house and in the field.

The latter two proposals have been implemented by a small number of military contractors, and have resulted in improved MOTD. Requiring TM writers to be graduate engineers is particularly effective when dealing with state-of-the-art electronic equipment. Requiring hands-on equipment experience is critical in that TM writers should be competent performers of the work for which they prepare instructions for others to perform.

The proposal requiring certification of TM writers has not been implemented to date. The cost of such a program appears to be a constraining factor, as well as determining who should set the standards for certification, and what those standards should be.

TABLE 3-XXI. PROPOSED IMPROVEMENTS TO THE TM PLANNING PHASE OF WRITING TASKS

Proposed TM Planning Phase Improvement	Extent of Contractor Implementation	Effect on MOTD
Total Use of Data Houses	Minimal	Negative
Selective Use of Data Houses	Substantial	Negative
Use of Design Engineers to Write TMs	Minimal	Negative
Establishment of MOTD Engineer Position	None	Unknown
Certification of TM Writers	None	Unknown
Requiring TM Writers to be Graduate Engineers	Substantial	Positive
Contractor TM Writer Training Courses	Minimal	Positive

3.3.2.5 WRITING TASKS FOR THE TM DEVELOPMENT PHASE

Automation will significantly alter the manner in which the content generator does his job. Advancing technologies such as interactive display consoles and computer graphics will require the content generator to develop new skills to operate effectively.

Impact of Technology Advances - Media trends in generation and transmission of information are deemphasizing paper. Other data such as digiforms, microforms, and video are available and usable to communicate technical data and diagram information.

Remote terminals are now used to enter text or tabular information into a computer, withdraw it for update with no rehandling of unchanged portions, or make it available for use at another terminal, since one terminal can converse with another. Drawings can be entered into a computer by keyboard and light-penciled on a tube face, or by plotter through a digital processor. Drawings stored in digital form can also be output on either device.

Information in any of the data forms is convertible to any other data form by various devices. Graphics, text, and drawings are converted to microform for delivery to users and storage. Text and tabular graphics are converted to digiform by keyboard entry; drawings are converted to digiform by various digitizing devices. Graphics presentations are converted to video form by camera. Distribution and use of information need no longer be in the form in which it was created.

Advances in automation and computer-graphics could eliminate the need for parts listers and artists in the Illustrated Parts Breakdown (IPB) area. Parts data and engineering drawings for manufacturing purposes are already being computerized. The required sorting, addition of items such as Federal Stock Numbers, and conversion of orthographic drawings to isometric drawings in assembly or disassembly order may all be accomplished digitally. Implementation of this scheme would require dedication of a portion of existing hardware, purchase of some additional hardware, and development of the appropriate software.

Systems which function as the maintenance technician's interactive partner in the troubleshooting and repair process are presently in advanced stages of development. These systems employ computers to store detailed MOTD developed by the content generator, and special programming which allows a technician to access that data using a question-and-answer process. Generally, these systems consist of an interactive display console, a microprocessor and mass memory stored on floppy discs. As a result, the content generator may have to be a script writer/programmer who anticipates malfunction-symptom queries and indicates corresponding remedial actions.

The content generator traditionally depends upon orthographic mechanical assembly drawings as well as access to the hardware for the development of removal and replacement procedures. However, the use of three-dimensional rotational interactive graphic displays, interfacing with computers which contain mechanical assembly information, could expedite this process. Additionally, the problem of the content generator in gaining timely access to equipment would be eliminated.

Function of MOTD Engineer - In addition to technology advances, the proposed concept of an MOTD engineer would have significant impact during the TM development phase. Once TM writers are assigned, the MOTD engineer is responsible for supervising their efforts and assuring that the material they generate is acceptable. The technical manual writers assigned to each portion of a manual will be given the detailed book plan developed by the MOTD engineer, showing what is to be covered, the presentation approach to be used, and the depth of coverage for each topic assigned. The detailed planning indicates the bounds for each topic.

An additional function of the MOTD engineer would be to assure the adequacy and accuracy of the technical manual to the reviewing agency. The careful analysis performed during the preparation of the detailed book plan provides assurance that the technical manual will be complete. In addition, because the book plan is quite detailed and was coordinated with the using activities, assurance is provided that it will be adequate. The MOTD engineer will coordinate the validation of narrative material accuracy with design engineering and the validation of procedural material on the equipment. Additional validation is provided by the in-house activities that use the MOTD for assembly, test, checkout, and integration. During verification, the MOTD engineer will provide the support requested by the reviewing agency.

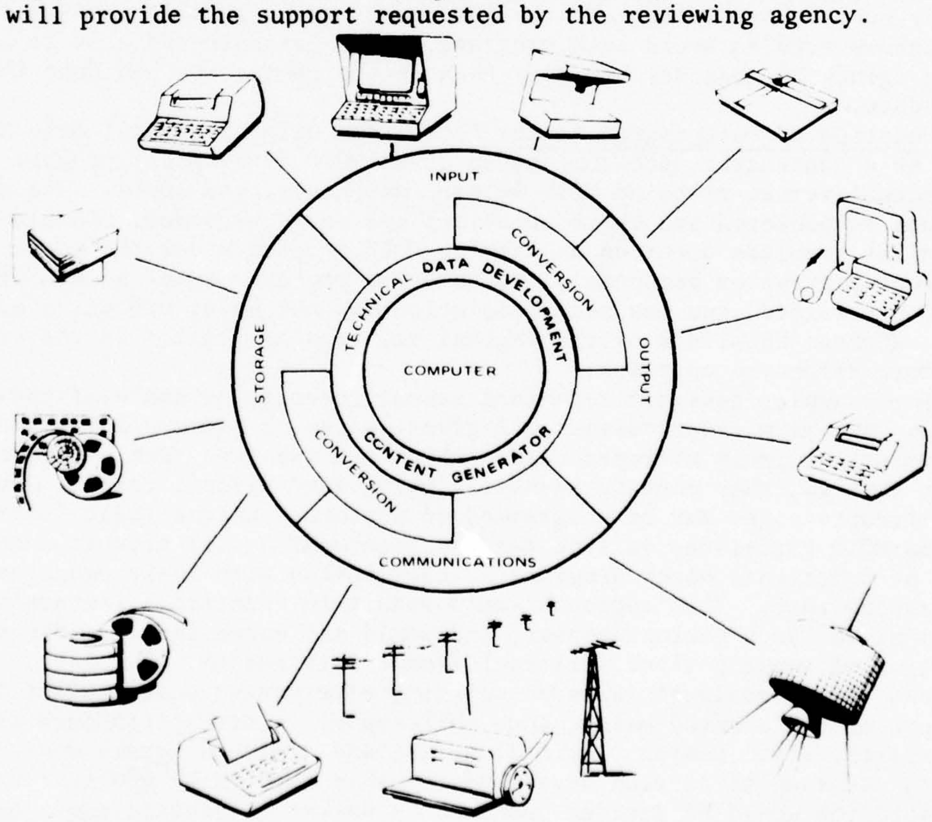

Figure 3-23. Advancing Technologies Impact on Content Generation. From these elements, an approach to a data methodology better suited for tomorrow can be evolved.

3.3.2.6 POST-WRITING TASKS

The Navy System Commands, as well as the non-Navy services, are moving toward internal development and production of all MOTD revisions rather than just out-of-production updates. The required Navy procurement of the contractors engineering/manufacturing/maintenance data bases presents a difficult problem in the area of maintaining data base integrity.

Trends in In-Production MOTD Updates - The trend toward internal Navy development of in-production MOTD updates (refer to topic 3.4.1.1), as well as the already existing Army and Air Force policy of performing selected in-production updates internally, requires dual military and contractor access to the existing data bases. One possible approach to such a system would be a single set of data bases developed by the contractor and turned over to the Navy for mutual access. This approach raises questions of maintaining data base currency, accuracy, and completeness in that the contractor would continue to develop system/equipment modification data.

Analysis of Air Force and Army programs reveals the existence of a serious problem when contractors are asked to perform an MOTD update which occurs subsequent to an update performed internally by the military. There is often no way for the contractor to easily determine what equipment revisions have already been incorporated into the latest MOTD configuration. As a result, contractors tend to avoid such programs, or to estimate the cost to the procuring agency at considerably more than if the contractor had done the original update.

Function of Postprogram Review Team - The only historical data accumulated by a contractor upon completion of an MOTD development program deals with actual versus proposed MOTD volume, man-hours, and costs. The myriad of problems encountered and their solutions are never recorded. Should the same or similar problems occur on an ensuing MOTD program under the cognizance of different contractor personnel, the solution process begins anew. Time and effort are wasted, and the second solution may not be as effective as the first, whereas knowledge of the initial solution may result in the evolution of a more effective approach.

For example, consider technical manual coverage of state-of-the-art devices such as microprocessors. A given system or equipment may contain many general-purpose microprocessors which are the same from a hardware viewpoint; that is, they contain identical integrated circuit chips. However, each microprocessor may be programmed to perform a unique logic function. Program MOTD guidelines calling for the treatment of all circuit cards by means of functional block diagrams in conjunction with logic equations would be inappropriate. This approach would result in identical diagrams and equations for each microprocessor, and would not cover the specific unique operation of these devices (critical from a maintenance viewpoint). Much time and effort would be expended weighing alternative presentation techniques in light of the adopted maintenance philosophy. Alternatives such as program flow charts, state tables, logic diagrams, and timing diagrams would be considered and samples of each developed for this particular application. The best solution would be decided upon, and a waiver to deviate from the MOTD specification would be obtained from the procuring agency.

Under the current contractor TM system, it is quite possible that a similar process would be undertaken for future programs dealing with equipment containing microprocessors. Contractors having large technical manual staffs are particularly susceptible to this problem.

To disseminate knowledge gained through conducting MOTD programs, it is proposed that a team be established to review the planning and development processes attendant to all major MOTD programs. (See Figure 3-24.) This team would consist of the contractor's MOTD engineer and his counterpart at the cognizant Navy System Command, as well as representatives from the contractor's technical writing, training, logistic engineering, and design engineering activities. Problems encountered, their causes and solutions, as well as user and customer comments, would be reviewed and analyzed. The resulting compilation of historical data will enable the procuring agency and the contractor to conduct future MOTD programs in a more cost-effective manner and will ensure the continual use of innovative approaches to MOTD development.

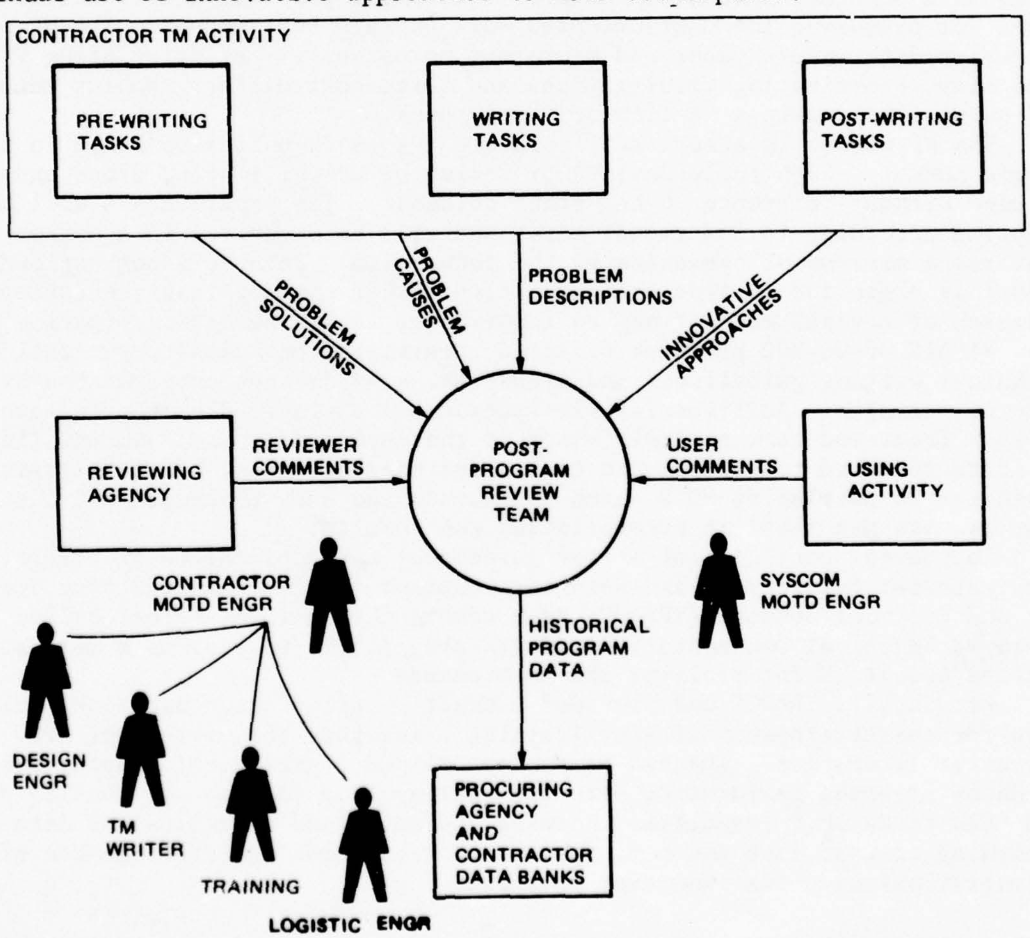

Figure 3-24. Postprogram Review Team Activities. The Postprogram Review Team ensures that valuable lessons learned on recently completed MOTD programs impact future MOTD programs.

3.3.2.7 TM PRESENTATION TECHNIQUES HANDBOOKS

Unlike current TM development guides (military specifications and handbooks), TM Presentation Techniques Handbooks presently under development have begun to focus on how to meet MOTD requirements.

The TM presentation techniques delineated in the writers' guides being developed by the NAVAIR System Command, Army, and the National Security Agency (NSA) emphasize the use of graphic illustrations supported by limited text. These handbooks describe how to develop material using the presentation technique selected. Descriptions are included explaining the procedure for data extraction and developing the technical manual as shown in Figure 3-25. The handbooks present examples of the writing style required for the presentation method and style guidelines to be followed by the writers.

NAVAIR 00-25-700, Technical Manual Preparation Guide for Technical Writers, Editors, and Illustrators which exists in preliminary form, is proposed as a supplement to MIL-M-81927. This guide provides additional guidelines for preparing the user-oriented work package (WP) manual. The WP format is designed to ensure paper and microform compatability by stipulating minimum type size, coordinating illustrations and text, controlling graphics methods, and using line drawings in lieu of photographs.

The WP manual is a series of separate WPs (work units) combined in a single manual. Each individual WP or series of WPs will stand alone and can be used without reference to any other document. The separate WPs will be compiled according to functional tasks and will be organized in a manner that requires a minimum of searching by the technician. Because a conventional manual is organized by type of information rather than by task (WP concept), a search of several manuals may be required to locate needed information.

NAVAIR 00-25-700 provides detailed information on manual organization, technical writing guidelines, and illustration guidelines complemented by numerous samples. Additionally, instructions are provided on how to accomplish a front-end task analysis which is the development and documentation of all data required to perform the task under consideration. Task analysis is essential in developing MOTD which represents the best procedure and the one that is most practical in accomplishing the results.

To prevent conflicts of writer guidelines and duplication of effort, the Army Materiel Development and Readiness Command (DARCOM) and the Army Training and Doctrine Command (TRADOC) have combined in a joint effort called Improved Technical Documentation and Training (ITDT) to provide a more standardized usable TM for training and maintenance.

Previously, TRADOC had provided a draft writers' guide handbook, Guidebook for the Development of Army Training Literature for writers of Army narrative literature. Instead of conceptualized topic-oriented data, the handbook stresses performance-oriented writing that focuses on "what to do" and "how to do it," identifies the user audience, and organizes the data according to user task and performance. The handbook requires the use of illustrations over text wherever possible.

The Army Maintenance Management Center (a part of DARCOM) developed a preliminary MIL-M-63038 specification and MIL-HDBK-63038 writers' style guide and handbook to be used during a test and evaluation of organization maintenance TMs. The guidelines detailed in the writers' guide handbook combine drawings and text together, and progress from an overall general drawing down through the major assembly, assembly and subassembly drawings with keyed text and signals.

The ITDT program has been chartered to formalize coordination between DARCOM and TRADOC. This joint effort was created to assure (through the development of specifications and writer guides) that all future technical documentation is usable for both training and maintenance, to provide a viable medium for information exchange, and to improve the training of personnel and the operational readiness of ARMY materiel. The MOTD packages developed under the ITDT program will be used for training, field maintenance, and on-the-job training. The training portion of the package makes use of hardcopy (paper), audio-visual equipment, and training simulators which are tied to a particular type of Army equipment. A Training Guide Manual is also included for field supervision use in developing on-the-job training programs.

The National Security Agency (NSA) has prepared a handbook, Diagram Oriented Documentation System Guide (DIODS) for use by the agency writers and editors. DIODS uses technical illustrations as the primary presentation technique with text to support the illustration. DIODS requires three types of manuals to support most systems.

1. System/Subsystem Manual - block and flow diagrams describe system and subsystem capabilities, performance characteristics, functional description, and interfaces.
2. Operator Manual - illustrations with supporting text and tables provide all operating instructions plus emergency/operator repairs.
3. Maintenance Manual Block - flow and logic diagrams provide all troubleshooting and scheduled maintenance information.

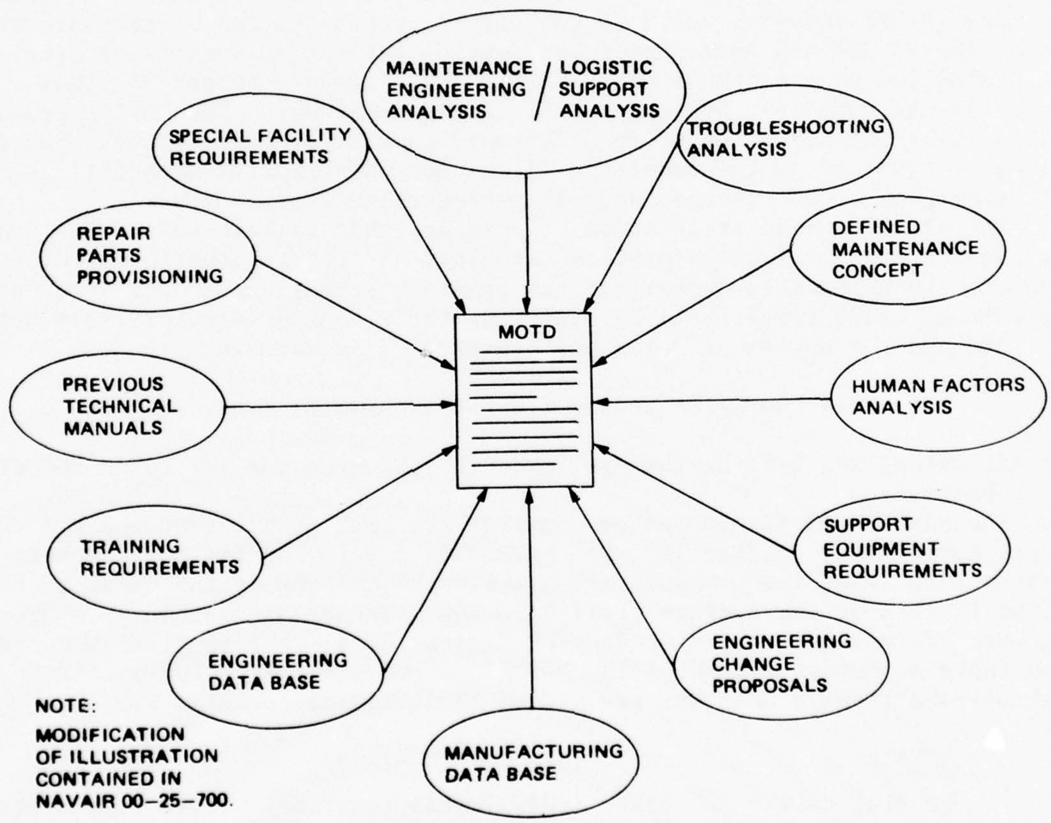

Figure 3-25. *Proposed TM Presentation Techniques.* Handbooks will detail the tasks to be performed and the source data to be reviewed by the MOTD developer.

3.3.2.8 WRITERS' GUIDE FOR READABILITY AND COMPREHENSIBILITY

The NAVSEA and NAVAIR System Commands, as well as the Army and Air Force, are planning the implementation of detailed TM Readability/Comprehensibility guidelines. With the exception of the Air Force, these guidelines will cover both text and graphic material.

Five different measurement formulas are presently being considered by NAVSEA, NAVAIR, the Army, and the Air Force for evaluating TM readability. The Automated Reading Index (ARI) evaluates all textual material, while the Flesch, Reading Ease Score, Fog Count, FORCAST, and Reading Impact Difficulty Estimate (RIDE) formulas evaluate randomly selected samples of textual material. The NAVSEA and Army approaches provide for larger numbers of samples for evaluation as the number of TM text pages increases (under 26 pages - 3 samples minimum; over 560 pages - 32 samples maximum). The NAVAIR proposal provides for the selection of four 100-word samples of text from each of the following types of TM information: (1) general/descriptive material, (2) principles of operations, and (3) procedural matter.

The ARI is a completely automated process that is best suited for grading the reading level of in-process material. A special counting machine is connected to a modified typewriter and provides a continuous evaluation of the Reading Grade Level (RGL) by analyzing the number of strokes (keys hit) per word and the number of words per sentence. The formula is:

$$RGL = 0.4\ (\text{words/sentence}) + 6\ (\text{strokes/word}) - 27.4$$

The ARI method was used by the Air Force to write the C5A TMs to an RGL of 10 or below.

The NAVSEA and NAVAIR System Commands are both planning to use the Flesch formula for grading TMs, but NAVSEA is specifying the more recent version that takes into consideration the technical RGL of the naval technician in lieu of the average civilian's RGL. The NAVAIR method is a "reading ease" formula developed by Rudolph Flesch (1948) that requires a conversion table to obtain the RGL. The NAVSEA method provides RGL directly from a simplified formula that was revised in 1975. These formulas are:

<u>NAVAIR</u>

$$\text{Reading Ease} = 206.835 - 1.015\ (\text{words/sentence}) - 8.46\ (\text{syllables/100 words})$$

<u>NAVSEA</u>

$$RGL = 0.4\ (\text{words/sentence}) + 12\ (\text{syllables/100 words}) - 16$$

The Flesch method can be accomplished manually (very slow and tedious) but is recommended for use on existing material with the aid of a special Flesch counter.

The FOG count formula is a completely manual method (no machine required) developed in 1953 for Air Force evaluation of existing TMs. This formula, used by NAVAIR, requires counting the total number of words and sentences, and the percentage of "hard" words (3 or more syllables) in a 100-word sample. All numbers, symbols, and common nomenclature are excluded. NAVSEA uses an unrevised version that includes all numbers, symbols, and common nomenclature by considering them as "easy" words (less than 3 syllables). The data are inserted into the following formulas to obtain the RGL of the sampled material:

NAVAIR

$$\text{RGL} = 0.4 \; \frac{\text{Total Words}}{\text{Total Sentences}} + \%\ \text{Hard Words}$$

NAVSEA

$$\text{RGL} = \frac{\dfrac{(\text{Easy Words}) + 3\ (\text{Hard Words})}{\text{Total Sentences}} - 3}{2}$$

The FORCAST and RIDE formulas are methods the Army is proposing to use to evaluate material during the in-process writing phase. No special machines are required for the writer to periodically check the RGL of the material he is preparing. FORCAST (from the developers Fox, FORd, CAylor, STicht-1973) uses the number of one-syllable words in a 150-word sample and applies this formula:

$$\text{RGL} = 20 - \frac{\text{Number of One-Syllable Words}}{10}$$

The RIDE formula was developed in 1973 and uses the average number of letters per word for a 100-word sample. A table is used to provide the RGL of the TM evaluated.

The Army is presently planning to tighten the readability/comprehensibility criteria of specification MIL-M-38784A by removing the "acceptable" criteria of 20-word average sentence length (ASL) and 1.6-syllable average word length (AWL), and retaining only the more restrictive "desired" criteria of 17 ASLs and 1.5 AWLs.

The proposed guidelines of NAVAIR 00-25-700, Technical Manual Preparation Guide for Technical Writers, Editors, and Illustrators; NAVSEA rough draft specification (dated 5 February 1976) Requirements for Technical Manuals: Readability/Comprehension; and the Army's draft MIL-HDBK-63038, all add criteria for text and graphic comprehensibility (shown in Table 3-XXII). NAVAIR and NAVSEA both require an RGL of nine and are each proposing similar graphic requirements.

3.3.2.8 WRITERS' GUIDE FOR READABILITY AND COMPREHENSIBILITY (Continued)

Proposed Army text and graphic comprehensibility requirements (shown opposite) are delineated in the Army Materiel Development and Readiness Command's (DARCOM) MIL-HDBK-63038 and the Army Training and Doctrine Command's (TRADOC) handbook, Guidebook for the Development of Army Training Literature.

The proposed use of readability measurement formulas (automated and manual), combined with the implementation of text and graphic comprehensibility requirements, are first steps toward the development of easily understandable MOTD. However, a number of critical items have not been addressed. TM writer training courses are needed to emphasize readability criteria and pitfalls, such as long sentences, inflating words or phraseology, and circumlocutions. An evaluation of the various proposed readability formulas is required to determine which is most easily implemented and provides the most accurate measure of the military user's understanding of TM material.

TABLE 3-XXII. PROPOSED WRITERS' GUIDE FOR READABILITY/COMPREHENSIBILITY

	NAVSEA		NAVAIR		ARMY		AIR FORCE	
Readability Measurement Formulas	Text	Graphics	Text	Graphics	Text	Graphics	Text	Graphics
ARI (100% Automation)	X						X	
Flesch (50% Automation)	X		X					
FOG (No Automation)	X		X					
FORCAST (No Automation)					X			
RIDE (No Automation)					X			
Reading Grade Level	9		9					
Comprehensibility Requirements								
Sentences/Paragraph	2							
Words/Paragraph	60							
Words/Sentence (Average)	15 - 20				17			
Syllables/Word (Average)	1.5				1.5			
Percent Pictorial (Average)	25%							
Headings/Page (Maximum)	2							
Paragraphs/Heading (Maximum)	2		2					
Figures/Heading (Minimum)			1					
Procedural Sentences (Minimum)			90%					
Personal Sentences (Minimum)					15%			
Mechanical Callouts (Maximum) Nomenclature 7" x 9" (Maximum) Number 7" x 9" (Maximum)		$5/in.^2$ 20 50		$5/in.^2$ 20 70		 20 50		
Electrical Components Maximum/Page Bunching Maximum		 80 $12/4\ in.^2$		 80 $12/2\ in.^2$		 $3/in.^2$		
Wire Intersections		$10/2\ in.^2$		$20/2\ in.^2$		$20/2\ in.^2$		

SUBSECTION 3.4
RESEARCH ISSUE 4: CONTENT CAPTURE

3.4.0 DEFINITION AND OBJECTIVE OF CONTENT CAPTURE

Maintenance and operating technical data (MOTD) created by the content generator must be transformed into text and graphic entities for production as book pages to be replicated into paper or film media and distributed to the user. However, content capture is likely to undergo significant change in adapting to developing MOTD media.

The challenge of the content capture function is to transform draft MOTD into a form and format that will enable effective performance by the user. It is part of the bridge, along with the replication and distribution, between the creation and use of MOTD. The processing of MOTD may be manual or automated, or a combination of both, but follows a singular functional path, as shown in the following figure.

Content capture combines the functions of text processing, graphics processing, and production. Production is the merging of text and graphics into a form suitable for replication as a document in the desired form or media. As long as the presentation methods remain page-oriented, the functional requirements and flow remain the same, even in highly sophisticated digital systems.

Text processing ranges from manual systems (using standard typewriters) through the tape-, diskette-, or card-assisted typewriters (whether time-shared to a central processor or decentralized with each machine having its own processor). Computer-assisted text processing hardware and software are presently well developed and are being used more and more in support of the content capture needs in both contractor and government operations. The more effective approaches tie the MOTD capture function into automated engineering data bases to minimize the re-creation of data. If engineering data is automated and text processing is also automated, then selected data created in the engineering process may be lifted from the engineering data base for use in MOTD with little or no additional processing. Presently, all systems are keyboard-constrained, that is, all input must be keyboarded to be input. Looking ahead, a potential input mode is a voice recognition system, in which the computer receives and reads in the dictated input from the author. A considerable increase in input speed is potentially available using this method. Voice recognition will be further discussed in 3.4.2.5.

Graphics also range from manually prepared drawings to computer-assisted drawings, with the former being the most prevalent. Computer-assisted graphics processing is not as well-perfected as text, insofar as it pertains to the content capture function. Technologically, it is well developed, but its questionable cost-effectiveness has delayed its use. In addition, system designers have not looked in depth at the total technical information (text and graphics) publications requirement. Rather, the present systems have been developed for computer-aided design and manufacture (CAD/CAM). A very effective method of employing systems designed for CAD/CAM uses the engineering drawing data base and reprocesses the drawings to the publications format. Perhaps the most significant handicap in extending the use of computer graphics is the amount of digital storage and processing space required, compared to text alphanumerics. One possible solution to this problem, at least for diagrams, is presented in 3.4.2.6.

The use of manual methods of preparing graphics will continue for some time. Several types of graphics do not lend themselves to current automation approaches. Graphics with color (FOMM) or grey tones (for reproduction as halftones), and some forms of mechanicals, such as exploded views, are difficult to handle. This factor added to the cost and other technological shortcomings of computer-assisted drawing tends to slow down its acceptance and use.

The production function, also traditionally manual, is rapidly becoming more automated. Text and graphics processed by a computer-based system can be output or produced directly into the media needed for replication - camera-ready repro or microform masters - using photocomposition or computer output microform (COM) equipment. Again, looking ahead, this digital output could also be provided directly to the user for his conversion to a medium of his choice.

With the increased use of computer-based MOTD capture, the areas of computer development and storage methods require consideration. The development of microprocessors is occupying the strong attention of all computer and peripheral manufacturers. Minicomputers continue to be improved. The needs of the 1980's will be well served by technological developments of this highly competitive industry. Storage, related to computer processing, is generally keeping pace. New storage methods are being projected, including bubble memories and solid-state storage media. Also, more immediately pertinent to NTIPP are developments in video disc and holographic storage. This will be further discussed in 3.4.2.7.

Bringing the content capture functions into focus presents a picture of double transformation - The transformation of the MOTD from generation to use, and the transformation from a manual to an automated environment. The transform in both cases is becoming digitally oriented. The automated systems are now digital, and the delivery of technical information to the user may also become digital. The "far-out look" in this environment shows the potential for:

- Centralized Navy technical information data banks - always current data
- Netted mini-computer systems for central control of processing and data - interacting the contractor with the Navy
- Extensive use of engineering data banks - for re-creation of engineering to MOTD
- Combined text and graphic processing systems for MOTD - package processing
- Data delivered to the user in digital media for user conversion to paper, film, visual image, or other - a changing role in capture, replication, and distribution.

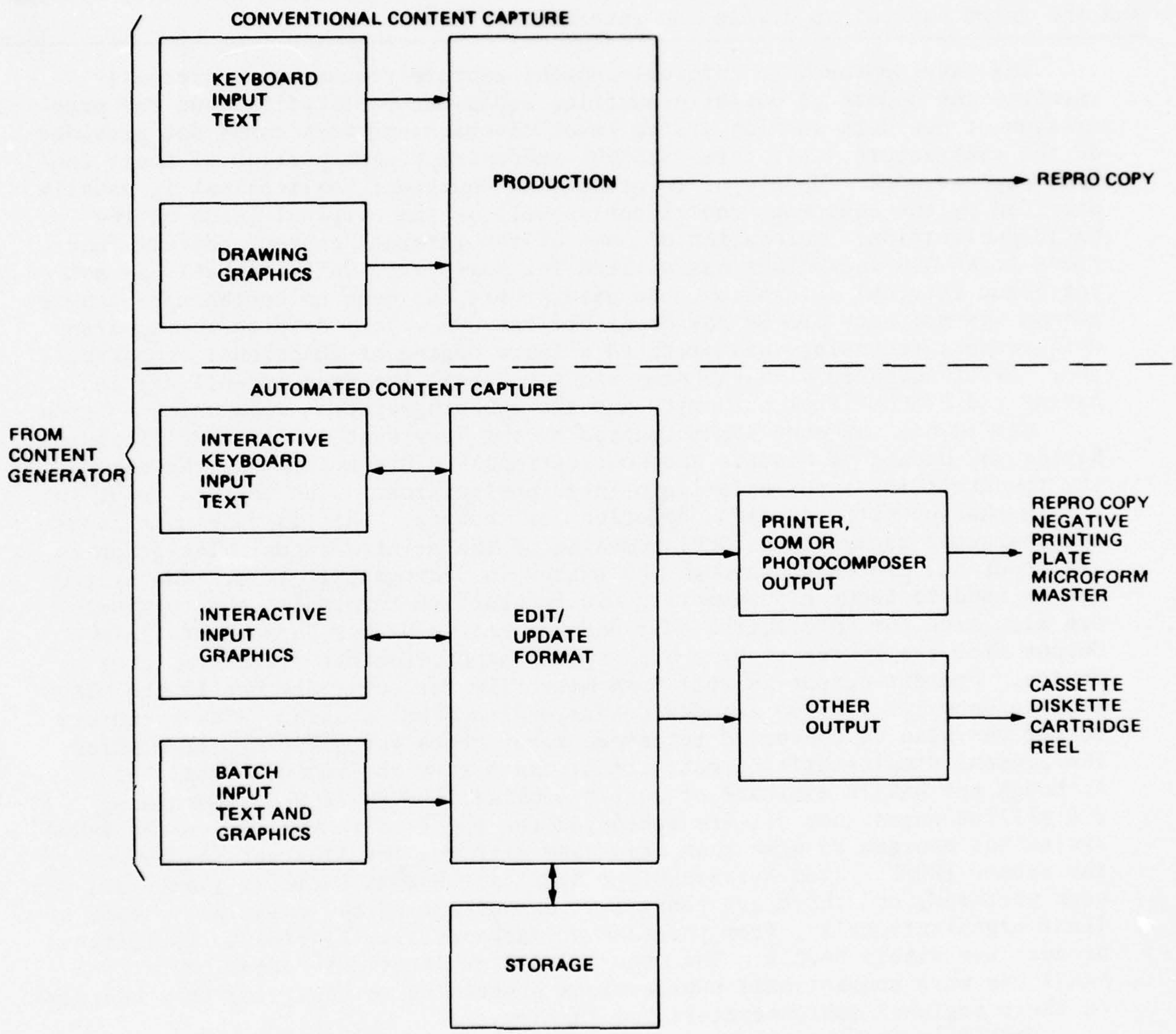

Figure 3-26. Conventional and Automated Functional Flow. Method and combinations of the two are found in today's content capture operations.

3.4.1.1 NAVY PUBLICATIONS SYSTEMS: CONTENT CAPTURE ASPECTS

No Navy-wide common system for content capture now exists. The three SYSCOMs are pursuing separate but similar paths - two have evolved internal, automated systems and the third has yet to develop an internal approach.

The Navy approach to internal content capture requirements presently involves the update of out-of-production equipment publications and the preparation of new data such as system level coverage and work cards not provided by the contractors. All three SYSCOMs subcontract some portion of their content capture work. Update of in-production equipment publications is usually provided by the equipment contractor as well as the original issue of the basic publication. Automation of some of the internal content capture functions at NAVAIR and NAVSEA has existed for some time, while NAVELEX has not yet begun internal automation. To date, there has been no common approach or common system; each SYSCOM has developed its own. Yet, despite the apparent differences, technology has dictated a large degree of functional compatibility. Also, compared with the Army and Air Force, the Navy is well off in having the SYSCOM-level authority and the existing systems from which to grow.

NAVAIR has the most sophisticated of the Navy systems in TRUMP (Technical Review and Update of Manuals and Publications). This system has the capability to accept for input existing printed publications. The text is input in a form that permits addition, deletion, or changes. This is done using optical character recognition (OCR) scanning of the printed pages. The graphics are input and processed through the system in photographic form. The system can be used to input alphanumerics via interactive terminals; the terminals are also used for interactive edit and correction of the data input via OCR. Output from the system is by a high-speed computer-output-microform (COM) device. Present output is roll 16mm microfilm for cartridge use in the MIARS (Maintenance Information Automated Retrieval System) program. The microform output can also be converted to camera-ready repro for printing, if desired. The present single-shift output rate of the system is 110,000 pages/year. Although the NAVAIR estimate of active publications is 25,000, containing 2.5 million pages, not all are scheduled for input to TRUMP. Since the TRUMP system has managed to more than keep pace with the input/output requirements, the second TRUMP system for San Diego Naval Air Rework Facility (NARF) has not been procured, and there are considerations of moving the existing system, at least organizationally, from the NARF at Jacksonville, Florida to facilitate broader use within NAVAIR. The other NAVAIR publications operations at the NARFs use more conventional publications processing methods, and rely heavily on their regional subcontractors for support.

NAVAIR is looking at the ways and means of obtaining the publications data base from contractors when the original issue of the publication is produced. This would permit outputting the original issue and preparation of any or all subsequent updates (including in-production equipment publications) to be performed by the cognizant field activity. The only effort to date has been visits to and meetings with several contractors and issuing a purchase order for a digital tape of a set of parts catalogs. It was determined that technical publications data bases, presently available, range from typewritten

pages and copies of manually prepared artwork to digital data on both text and graphics. However, the effort is preliminary and the information inconclusive. Further in-depth study and analysis is needed. This subject is discussed further in 3.4.2.4.

The NAVSEA system is called ADPREPS (Automated Document Preparation System), and consists of cassette terminals that can function as off-line input devices or interactive (to the computer) terminals. The computer used in this system is located at Corona, California, which is over 100 miles from the location of the balance of the system at the Naval Ship Weapons Systems Engineering Station (NSWSES), Port Hueneme, California. This computer is also used for a variety of operational and tactical purposes, and is not always available for use by ADPREPS. Processing is further complicated by having some handling and processing done by the automated data processing activity at Port Hueneme. Only alphanumerics are processed on the system, while graphics are performed manually. The output device used in ADPREPS is a high-speed photocomposition unit which provides camera-ready copy for printing. Although this output device has the production capability of thousands of pages a week, it is not used to its full capability at present. There is no attempt to input existing printed publications. A current plan is underway to augment ADPREPS to include its own central processor and peripherals to provide an independent capability. This is a joint NTIPP/SEA03 effort being performed by Stanford Research Institute. Other than the ADPREPS system at NSWSES, Port Hueneme, the other NAVSEA publications activities use conventional publications processing methods and subcontractors. NAVSEA, like NAVAIR, is also considering picking up contractors original issue publication data bases to provide a capability for subsequent updates.

Input and processing of MOTD using the NAVAIR/NAVSEA automated systems has, to date, been limited to alphanumeric (text) data. Preparation of graphics has not been automated. The conventional manual methods of preparation and handling (except for the 105mm copy used in TRUMP output) have been employed in internal publications operations.

NAVELEX is essentially oriented to performing its content capture functions using subcontractors. There is no indication that an internal automated capability is presently planned. NAVELEX has not had the funds or organizational structure directed toward these pursuits as has NAVAIR and NAVSEA.

Estimates of the current Navywide technical manual inventory range from 120,000 to 135,000 TMs comprised of nearly 25 million pages of which 60 to 70 percent are text pages. NAVSEA has 68 percent of the TMs in inventory with NAVAIR and NAVELEX having 18 and 14 percent, respectively. In page count NAVSEA jumps up to 81 percent, NAVAIR almost 9 percent, and NAVELEX over 10 percent. More significant are the estimates on new and update workflow. A recent Stanford Research Institute (SRI) report[1] states, NAVSEA issues new or completely reissues 10,000 TMs with 2,850,000 pages and they update an

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[1] J. J. Bialek, P. Whiting-O'Keefe, "A Study of the Requirements and Alternative Designs for Automating the Publication of NAVSEA MOTD at the NSDSA," Stanford Research Institute, January 1977.

3.4.1.1 NAVY PUBLICATIONS SYSTEMS: CONTENT CAPTURE ASPECTS (Continued)

additional 240,000 to 400,000 pages each year. Also, of the 51,000-page backlog of out-of-production equipment TMs they update between 5,300 to 16,000 pages each year. Very little new and update work has been handled internally by NAVSEA - only 17,000 pages last year and 80 percent of that was subcontracted. Less than 1 percent of the current yearly TM effort is done internally by NAVSEA and only a part (about 3000 pages) is processed on ADPREPS.

NAVAIR issues 1100 new TMs (including 350 for foreign buys of USA airframes) with 110,000 pages and they update an additional 40,000 pages each year. No data was available on complete reissues. Their backlog of out-of-production equipment TM pages is about 15,000 with 1000 entering this category each year. No data was available on the NARF TM page production, but it is estimated that only about 2 percent of the total TM production effort is done internally. Apparently of the 100,000 pages a year being converted by TRUMP only a small number are being updated at that time.

NAVELEX issues about 500 new TMs with approximately 77,500 pages and updates an additional 50,000 to 75,000 pages each year. No data was available on complete reissues of their TMs. The backlog of out-of-production equipment TM pages is estimated at 100,000 with about 6000 entering this category each year. NAVELEX has done virtually no internal processing using subcontractors to meet their requirements.

Since these figures have reportedly been consistent at these levels over the past few years it is probable that there will be no wide variation over the next few, unless there is a significant change in the total Navy (or DoD) posture or a far-reaching technological breakthrough in weapon systems. Projections into the next 5 to 10 years using these figures should be reasonably valid.

The significance of the above page processing data is really to show the size of the effort the Navy is performing and will be performing in the future. Any plans, such as those to develop an internal (to the Navy) data bank of MOTD must consider such factors as how to store the 30 million-page inventory and how to handle the 3 to 4 million new pages yearly, of which one-third are illustration pages.

In general, both TRUMP and ADPREPS were developed to address specific defined tasks (TRUMP for some update and ADPREPS for some internally generated new material) and were not designed as tools to do all NAVAIR and NAVSEA technical publications processing. Very little original MOTD is not generated by contractors, and, as cited above, only a part of the update is processed by internal Navy capabilities. However, this is likely to change in the future.

In comparing one SYSCOM to another, the differences lie in their approaches: NAVAIR capturing existing printed publications, NAVSEA with a conventional input/processing/output system, and NAVELEX predominately vendor-centered. There are also differences in their media approaches: NAVAIR now looking at microfiche for some applications and into cartridge microform (MIARS) for many years, NAVSEA and NAVELEX, presently using only paper media, are just beginning to implement microfiche. These same areas are also where

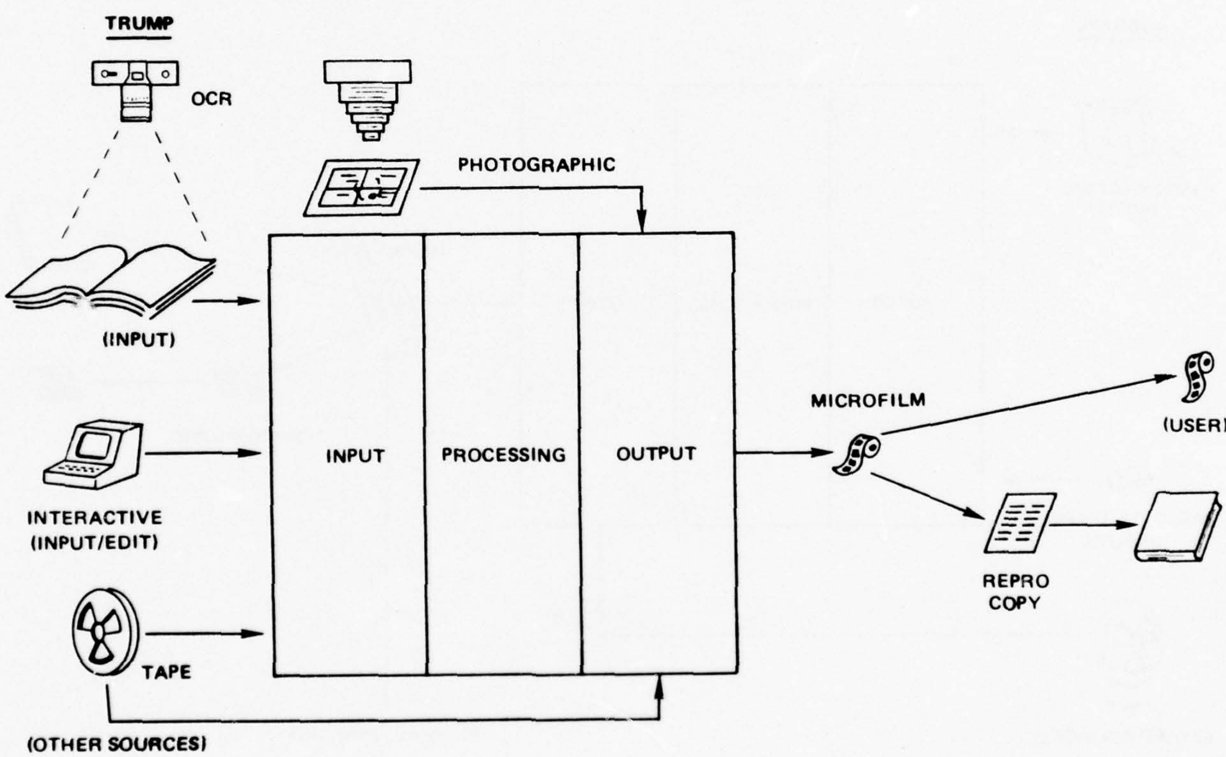

Figure 3-27. TRUMP is an Advanced System. It employs a sophisticated optical character recognition (OCR) subsystem as an input device.

3.4.1.1 NAVY PUBLICATIONS SYSTEMS: CONTENT CAPTURE ASPECTS (Continued)

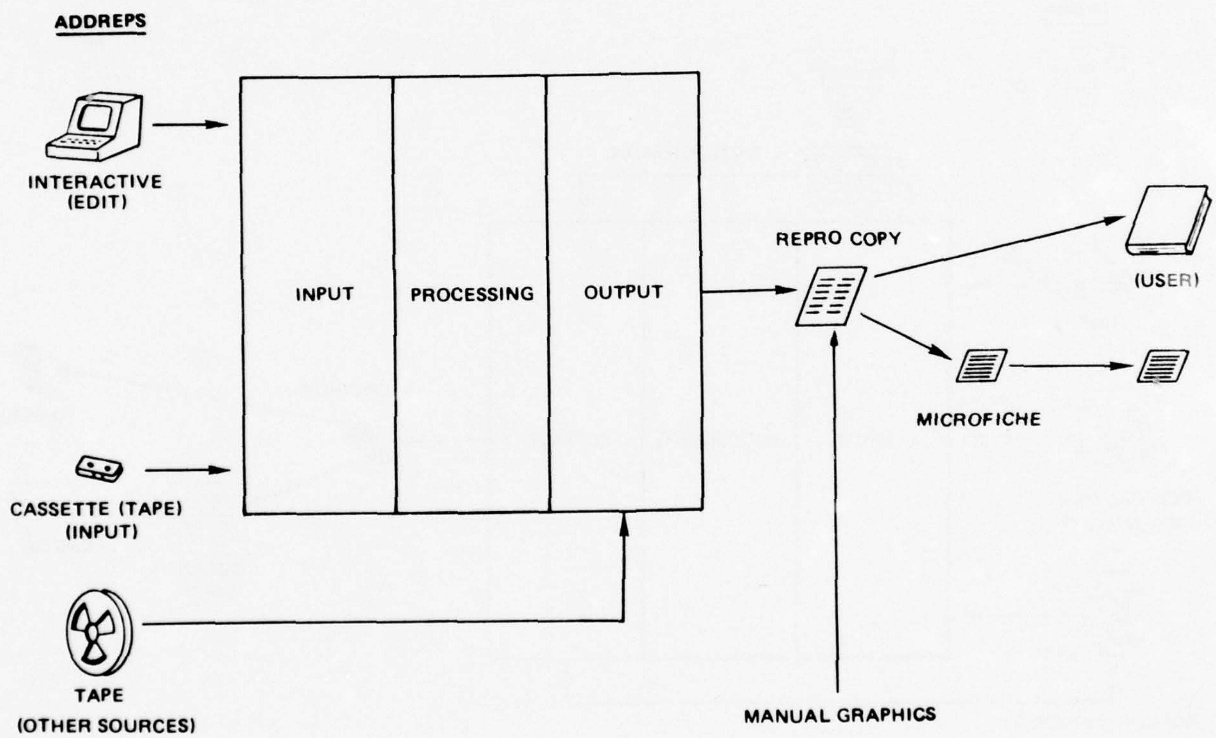

Figure 3-28. ADPREPS Improvement Program. Repro copy is the present output which can be processed photographically to microfiche when required.

the similarities occur, and they are strong indicators of the future. NAVAIR and NAVSEA both have expressed aims to capture the contractor publication data base, and NAVELEX could well join on this. NAVAIR and NAVSEA are both automated and looking to more automation - a digital environment. Again, although not there yet - NAVELEX could soon catch up. Transition to these positions will take time, through the planning approach and funding cycle; involve substantial further investment; and be enmeshed in DoD/Navy/Industry standardization and commonality programs. All in all, the Navy has taken several giant strides toward effective content capture capability. The current systems are the beginning.

3.4.1.2 ARMY/AIR FORCE PUBLICATIONS SYSTEMS: CONTENT CAPTURE ASPECTS

The Army and Air Force publications system approach is one of centralized control and management, with all participants doing the same thing in much the same way. Content capture automation in the Army is lagging both the Navy and Air Force, while the sophistication of the Navy approaches is somewhat greater than either of the others.

Content capture requirements in other military services do not differ extensively from the Navy, as seen in Table 3-XXIII. Both the Army and the Air Force have internal content capture capability. The requirements of the Army are very similar to the Navy, inasmuch as the Commodity Commands perform much of their own update of both in and out-of-production equipment publications. The Army also prepares some new data of the system integration and special application type. They also use subcontractors to assist in these efforts. The equipment contractor prepares the original issue of the basic publication and none, some, or all of the updates. The Air Force, through the Systems Commands for initial procurement and the Air Logistics Centers during deployment and operation of systems and equipment, operates in much the same manner as the Navy for new data and update requirements. The Air Force does perform update of in-production equipment publications in some instances, and the contractor may also perform updates on the same program. The Air Force also uses subcontractors to assist meeting internal content capture needs. Both the Army and the Air Force have some automation.

The Army centralizes their control through the Maintenance Management Center (MMC). However, this agency does not become involved in internal processing functions such as content capture. The internal content capture function at three of the six Commodity Commands has been automated using the Astrocomp system. Astrocomp is a commercially available "turn-key" system with hardware and supporting software. The system is comprised of a mini-computer and several (up to 12) interactive terminals. A set of input, edit, and output software is provided, and the system can interface to various output devices. Photocomposition and repro-quality impact printers are used for output. The Army does not consider the implementation of this equipment as significant automation. However, it does represent a beginning and can provide a base for future excursions into automation. Although the application of this equipment was not controlled by MMC, it is an interesting fact the three Commands informally agreed on the type of equipment. It can be assumed that the other three Commands, if they automate, will probably use Astrocomp since they were consistent in installing the Mosler automated engineering drawing (aperture card) retrieval system at all Commands. Only text is automated, while graphics represent a manual effort at the Commands using the Astrocomp Systems. The other Commands have essentially a conventional manual publications operation.

The Air Force has a central control through the Air Force Logistics Command (AFLC). This agency does become directly involved in internal content capture functions since the functions are located at Air Logistics Centers (ALC), subordinate organizations to AFLC. The Air Forces' excursion into automation has been limited to date, but future plans are extensive. Currently, three automation efforts have been identified. The first is the

G022 Program to automate AF Technical Order Indexes; the second is the D069 Program to automate inspection manuals and other special publications; and the third is the Automated Text Composition (AUTOTEC) System. AUTOTEC is basically located at Oklahoma City ALC and employs a large-scale IBM computer at that location for processing. The system is essentially an IBM Administrative Terminal System (ATS) enhanced for their needs. The output equipment used is the Linotron at Wright-Patterson AFB (AFLC). AUTOTEC, like TRUMP and ADPREPS, is the stepping stone to further automation. This growth into the proposed Automated Technical Order System (ATOS) will be discussed in 3.4.2.2. Graphics are not automated in the current systems; other than the work designed for the systems described, all other internal processing is done with conventional manual methods.

In comparison, the Navy has brought automation into content capture somewhat farther with a higher degree of sophistication than either the Army or Air Force. A notable difference is that the Army and Air Force have or are striving for a common approach across each of the services, while the Navy has different approaches within its organizations. This highlights a potential role for NTIPP to characterize and recommend an approach for development and implementation of this function. Generally, automation in all three services content capture functions is on the threshold of the digital world.

TABLE XXIII. COMPARISON OF CURRENT CONTENT CAPTURE MODES AMONG THE SERVICES

Content Capture Modes	Navy	Army	Air Force	Equipment Contractor
Content capture of original (new) MOTD	Yes	Yes	Yes	Yes
Content capture of in-production equipment MOTD update	Not a normal practice	Will often do some updates	Will often do some updates	Yes
Content capture of out-of-production equipment MOTD update	Yes	Yes	Yes	Not applicable
Automation	NAVAIR and NAVSEA	Three of six commodity commands	Some functions such as parts catalogs, T.O. Indexes	Some are
Sophistication (of automation)	High	Moderate	Moderate	Low to high
Standardization (degree)	Not to date	Yes - to date	Yes	None

3.4.1.3 OTHER PUBLICATIONS SYSTEMS: CONTENT CAPTURE ASPECTS

Content capture of other government agencies, commercial publications operations, and contractors parallels and/or interfaces the Navy's. Many system configurations for automation have been developed through the years with little control or standardization in hardware or software.

Other content capture organizations offer a diversity of individual approaches and modifications. Each is somewhat tailored, even though the functional entities are essentially the same. This is evident in the Stanford Research Institute technology assessment[1], and was confirmed by further NTIPP research. NTIPP investigations examined the following representative systems:

The publications systems of the Department of Agriculture (USDA) and the Department of Commerce, Bureau of the Census, are pertinent in that they have governmental controls similar to the Navy, and they are good examples of content capture automation. The USDA has 18 separate publications operations involving content capture, each of which has varied degrees of sophistication ranging from the magnetic tape selectric typewriters (MT/ST) to Astrocomp systems. There is also a Central Composition Office that has MT/STs, Magnetic Tape Selectric Composers (MT/SC) and miscellaneous other paper-tape-assisted typewriters for composition. USDA also uses the Government Printing Office (GPO) for content capture (design, composition, artwork, and production) on some publications. Standardization into a new state-of-art system for USDA is planned. This is discussed in more detail in 3.4.2.3.

The Census Bureau is attempting to capture content from the same digital data base used to process census and related data. They also use conventional text processing and subcontract some work. They have recently installed a high speed graphic quality computer-output-microform device to output both text and graphics (charts and maps) for their publications. Both USDA and the Census Bureau interface with the Congressional Joint Committee on Printing (JCP) and GPO in regard to some of their composition needs and plans. GPO performs some of their composition, or coordinates their subcontracts and JCP reviews, and approves their composition equipment requirements for high-speed computer-assisted composition devices.

Another parallel content capture activity in the Government is the National Science Foundation (NSF). Still in development is, to quote their description[2], "the concept of a central processing facility acting as a service bureau to perform automatically all the functions associated with primary publishing that lend themselves to processing by computers and other sophisticated modern equipment." The system, called Editorial Processing Center (EPC), provides automated editorial processing to the scientific community

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[1] Bialik, Whiting-O'Keefe, Humphrey, Zablocki; "An Initial Study of Current and Projected Publishing Technology Pertinent to the Navy Technical Manual System (NTMS)"; Stanford Research Institute; March 1976.

[2] Capital Systems Group; "Improving the Dissemination of Scientific and Technical Information: A Practitioner's Guide to Innovation," National Science Foundation; 1975-1976.

and relates to a grander scheme of netting this community into a large-scale information system. This approach will be discussed in 3.4.2.3.

A good cross-section of users and suppliers of content capture systems and equipment is provided in the previously referenced SRI report. Those surveyed include newspapers, government contractors, commercial publishers and manufacturers. In addition, Boeing Aircraft Company is noteworthy in that, in advance of the others, it has established an automated graphic capability to accompany its text processing function. (See Figure 3-29.) This system is dedicated to the publications activity and has 14 illustrator stations, and uses combined CRT, menu function keyboard, and a tabletizer (point-to-point tracing surface digitizer) for the input. Most types of graphics are output on the systems, including mechanical drawings and diagrams, along with some tabular diagnostic data.

Like other contractors having direct relationship to the military services and to NTIPP, Boeing has a system tailored to its individual needs. In the approaches analyzed, the functional characteristics are similar but selection of the means and degree of sophistication vary considerably. Selection of different hardware is not as much a problem as using different computer language, coding and communications interface. To approach the Navy's considered option to input and process contractors' publications data bases, the Navy must initiate a program of expeditious development and implementation of standards and controls, and authorize the funding to make it happen.

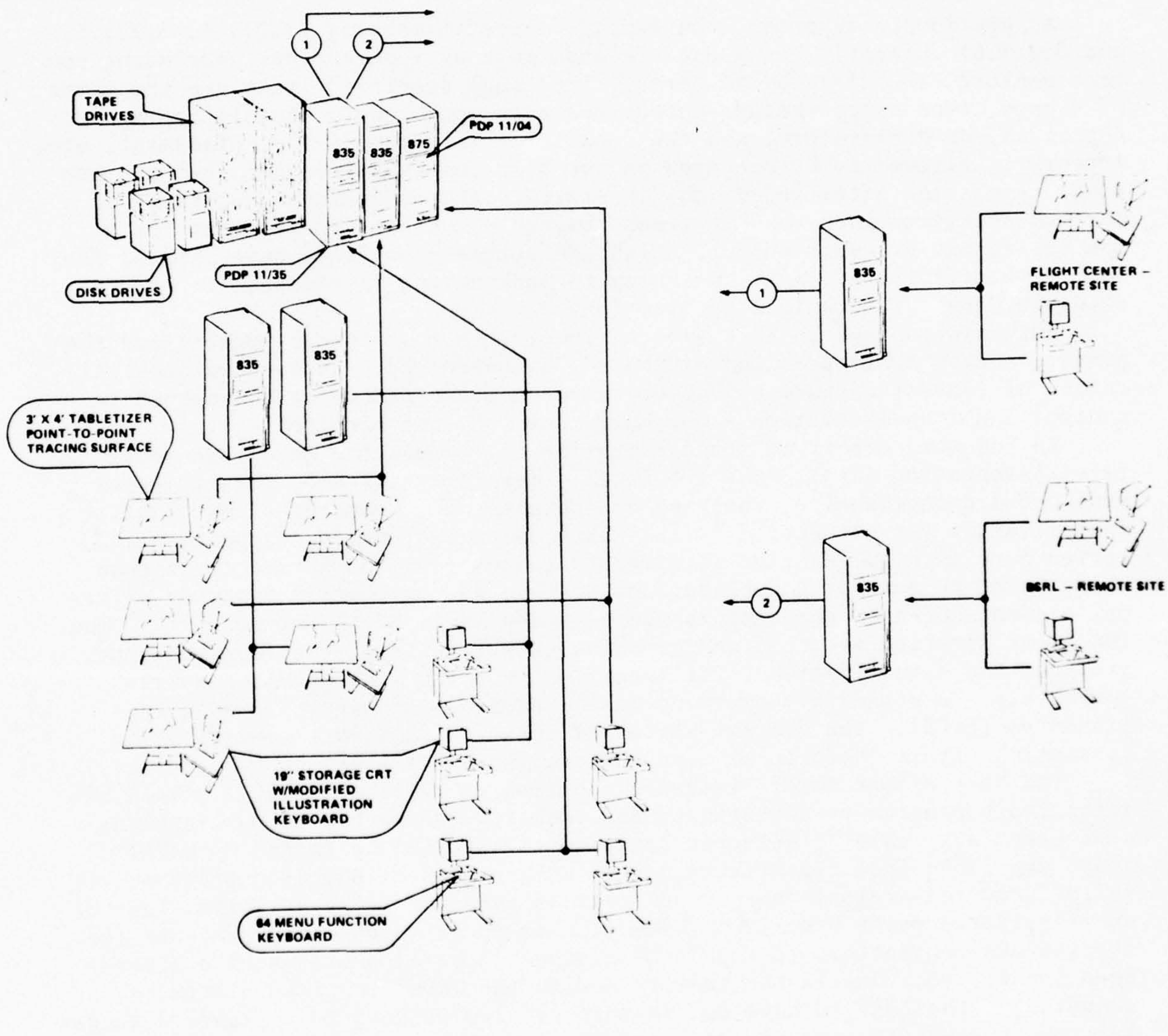

Figure 3-29. Publications System in Use at Boeing. A dedicated graphics processing subsystem and 14 work stations provide extensive capability in this state-of-the-art installation.

3.4.1.4 CONTRACTOR/NAVY INTERFACES INVOLVING CONTENT CAPTURE

Only limited interface has existed on content capture aspects of publications processing between the contractors and Navy in the past, and that was via specifications or contract requirements. One current approach to create interface standards for the growing automation has had some promising results.

As previously reported, the family of specifications (3.2.1.4, 3.2.1.5, and 3.2.1.6) currently being used relates to many requirements, including content capture, in fairly broad terms. The usual specified items are the format of a page; type size; whether output media is repro copy, photolithographic negatives, or a microform; and the details of film type, size, placement, etc. Artwork is allowed to be prepared in the most economical manner, but minimum final type size (after reduction) is stated. The predominant interface is through specifications, and at times through a contract requirement for a special format or media output. Although automated systems have existed for some time, efforts are just beginning to look at the interfaces for machine-readable data for technical publications.

The main message in this area of inquiry is that the government and the private sector exhibit an uncoordinated, uncontrolled, nonstandard sophistication of content capture. However, three current efforts are observed in control and standardization - one Navy, one DoD, and one industry.

An industry effort at standardization is through the Aerospace Industries Association (AIA), Pubs 106 Panel. Several years ago, the AIA Panel sent out a questionnaire, analyzed the results, and prepared a functional specification for automation.[1] This list, although termed a specification, serves more as a guide since it attempts to cover all potential functional elements of an automated publications system, and to specify singular critical elements such as computer language. (See Tables 3-XXIV thru XXVI.) The functions detailed are text and graphics entry, edit/update, format/output, storage, and communications. It specifies that the subsystems be ASCII-compatible - a standard conforming to the Federal Information Processing Standards (FIPS). The current status of the AIA functional specification is static. It is there to be used, but no further AIA action is pending.

The Navy effort toward interface control is just beginning. NAVAIR has initiated a program to investigate and identify the technical publications data bases available at selected contractors that can be tapped by NAVAIR. These can range from typewritten pages, with copies of the illustrations, to fully formatted digital tapes. One test is underway using a digital tape of an illustrated parts breakdown. The plan is to interface these outputs from the various contractors to the TRUMP system. Several problems have already been identified. One is the cost to modify the TRUMP input subsystem or, conversely, the cost to have contractors provide outputs to a standard singular, or at least limited, input requirement. Contractor reluctance to participate for various reasons is another factor, and will be discussed at length in 3.4.2.4, covering the planned Navy procurement and use of contractors data bases.

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[1] PUBS 106 Panel, "Survey for Automated Publication System Requirements," AIA, 1974.

The DoD effort is led by the Defense Logistics Analysis Office (DLAO) of the Defense Supply Agency, and involves all services.[1] The purpose of this effort is to survey the various means for producing, distributing, maintaining, and using technical manuals within DOD and to evaluate these with a view toward identifying the best method for producing, distributing, and maintaining such publications. The program has started, and is scheduled for completion in June 1977, but may take several additional months before action is initiated on its anticipated recommendations.

The interface between the contractor and the Navy needs immediate attention. Specifications have done an adequate job in defining form and format in conventional modes of content capture operations. However, the time to develop and implement standards in automation is imminent for machine-readable interface. With digital data a current and growing future mode of operation, the control of the interface problem becomes more acute and, therefore more expensive. A dynamic leadership role must be assumed soon - by a major contractor which interfaces all services, by an industry association, by a DoD committee, by one of the other services, or by the Navy. While all mentioned do have a vested interest in standards and there is no dynamic active program, perhaps the Navy should consider this role, since they do have developing advanced programs in automation of MOTD functions.

TABLE 3-XXIV. AIA PUBLICATIONS PANEL ENTRY SPECIFICATIONS

Item	Item

MODE
 	
ON-LINE
 	
• Direct keyboarding
 	
• Batch entry
  - Computer magnetic tape
  - Magnetic cassettes
  - Punched paper tape (PPT)
 	
• Graphic scanning
  - Line art (variable length and variable width)
  - Photographs (continuous tone and halftone)
	OFF-LINE
	
	• Batch preparation
	  - Computer magnetic tape
	  - Magnetic cassettes
	  - Optical Character Recognition (OCR) (PPT and magnetic tape)
	
	• Magnetic tape from other computer systems
	
	INPUT DEVICES
	KEYBOARD DEVICES
	
	• General characteristics
	  - Standard 44-key keyboard
	  - More efficient keyboard

[1] J. J. Bennett, Memorandum, "Analysis of Methods for the Production, Distribution and Use of Technical Manuals," Acting Assistant Secretary of Defense (I&L), 10 September 1976.

3.4.1.4 CONTRACTOR/NAVY INTERFACES INVOLVING CONTENT CAPTURE (Continued)

TABLE 3-XXIV. AIA PUBLICATIONS PANEL ENTRY SPECIFICATIONS (Continued)

Item	Item
- Keys, including space and backspace, reserved for text input - Supplemental command coding keys - 132 character line length - Cassette capability (off-line input preparation, on-line data entry) - Remote/portable terminal capability - Character displays correlate with input • *Selectric-type terminals* - Typefaces compatible with output impact printer • Visual Display Terminal (VDT) - "Output page" size display - Hardcopy capability - Terminal buffer area - Disk scrolling - Cursor capability • OCR scanning - Insensitive to one color - Output ASCII coded PPT - Computer magnetic tape - Direct interface to computer systems	• Graphics scanning/ digitization - Any length (continuous scan, multiple image scan) - Insensitive to one color - Scanner passes over stationary graphic - Photographs (continuous tone, halftone) - Scanning resolution compatible with minimum quality levels - Vector generation of characters and graphics - Possible standardization of output graphics sizes . Full page . Half page . Quarter page . Fold-out COMMUNICATIONS INTERFACE EQUIPMENT • Minimum of __ on-line terminals • Expandable to __ on-line terminals • Remote/portable terminal capability

TABLE 3-XXIV. AIA PUBLICATIONS PANEL ENTRY SPECIFICATIONS (Continued)

Item	Item
• Batch input interfaces - Computer magnetic tape - 7-track (800 bpi) - 9-track (1600 bpi) - Magnetic cassettes/ cartridges - PPT - Cards • ASCII compatible • Direct intercomputer communication • Data scanning interfaces STORAGE SYSTEMS • Active storage - Magnetic disk - Magnetic tape - File system . Absolute reference system . Password • Photocomposition font library	• Archival storage - Computer magnetic tape COMMAND CODING • Free form input - Applications programs interpret for output • Command input - Minimum keystrokes - Humanly understandable - Operators do not need graphics training - Automatic tabular alignment, realignment • Pagination commands (see Output Format) • Standard code convention for special character generation (Shall not conflict with text input)

3.4.1.4 CONTRACTOR/NAVY INTERFACES INVOLVING CONTENT CAPTURE (Continued)

TABLE XXV. AIA PUBLICATIONS PANEL EDIT/UPDATE SPECIFICATIONS

Item	Item
EDITING • Unit address • Absolute reference system • Global replacement, location • Variable data unit relocation • Data extraction • Wrong way/right way replacement • Editing verification-terminal • Nondistorting tabular editing • On-line alphanumeric sort	EDITING TERMINALS • Input terminals configured for editing use - Selectric - VDT . Cursor . Disc scrolling - Graphics terminal SPECIAL CONSIDERATIONS • Command simplicity - minimum keystrokes • All necessary system capabilities readily available to operators • Text and graphics merge • Command codes discernible from text • Formula and equation generation - special characters • Data conversion

TABLE XXVI. AIA PUBLICATIONS PANEL FORMAT/OUTPUT SPECIFICATIONS

Item	Item
MODE ● On-line ● Off-line - Computer magnetic tape - PPT DEVICES ● Impact printers - Selectric terminals - High speed printer - Medium speed, typewriter quality - Compatibility of typefaces ● VDT-hardcopy ● CRT-photocomposer - As output device - Computer magnetic tape driven - Graphics capability, including turn pages ● COM devices - As output device - Computer magnetic tape driven - Microfiche or variable size film output	● Photomechanical typesetter - As output device - Computer magnetic tape driven - PPT driven ● Special outputs - Photolithographic negatives - Printing plates PHOTOCOMPOSITION PROOF ● Output simulation on high speed impact printer CHARACTER SET CAPABILITY ● Efficient standard access code - English alphabet . Uppercase & lowercase . Punctuation, arabic numerals - Greek alphabet . Uppercase & lowercase . Alternate characters - Mathematical symbols - Technical symbols - Superscripts & subscripts - Oblique/Italic characters - Underline - Overline - Horizontal rule - Vertical rule

3.4.1.4 CONTRACTOR/NAVY INTERFACES INVOLVING CONTENT CAPTURE (Continued)

TABLE 2-XXVI. AIA PUBLICATIONS PANEL FORMAT/OUTPUT SPECIFICATIONS (Continued)

Item	Item
OUTPUT FORMAT ● Variety of output produced by applications programs from input codes - As-entered listings . With or without absolute references - Sentence spacing greater than word spacing - Tabular data alignment . Centered . Flush right . Flush left . Aligned on decimals - Text/graphic merging . Variable size graphics . Photographs Continuous tone Halftone . Reserved blank graphic space Fixed Floating Sequential - Pagination . Galley or pages . Headers and trailers - including automatic page numbering and document identification . Right-hand/left-hand pages	. Single/multiple columns . Justified copy Horizontal Vertical Increased leading Extra leading Top Bottom . Unjustified copy Ragged Right Ragged Left Ragged Center . Hyphenated copy Optional hyphenated/ unhyphenated copy Hyphenation dictionary/logic Hyphenation exception dictionary . Widow control . Keep and release . Footnotes - Marginal changed data symbols - Automatic numbering/ renumbering . Paragraphs . Figures . Tables . Figure and table references in text - Automatic front matter . Table of Contents . List of Illustrations

TABLE 3-XXVI. AIA PUBLICATIONS PANEL FORMAT/OUTPUT SPECIFICATIONS (Continued)

Item	Item
. List of Tables . Alphabetical Index . List of Effective Pages - Classification labels - text markings SPECIAL OUTPUTS • Photocomposition proof copy	• Graphics - Line art - Photographs • Photolithographic negatives • Printing Plates • Remote output • Interface to other computer systems

3.4.1.5 PRESENT TECHNOLOGY FOR CONTENT CAPTURE

Today's text processing technology provides both interactive and batch input to sophisticated data manipulation; meanwhile, processing graphics via the computer has long been a technological fact but not an operational one at present.

Previous reports prepared for this program have provided in-depth explanations of text and graphic processing and related technology. Both the SRI technology assessment[1], and a DTNSRDC technology report[2], cover the subjects in detail and two of the IBM reports[3,4] also provide some coverage of this subject area. Discussions in this topic will relate applications and approaches to content capture. Current or state-of-the-art text and graphic processing methods involve both interactive and batch input techniques. Each has its applications.

Batch Text Input - For text input, the batch methods can be efficient and cost-effective. One method is to type on conventional typewriters or typewriters with special type elements, and read the copy into an automated system using optical character recognition (OCR) readers. This system permits the use of most of the typewriters in an organization for input in saturation situations. It also facilitates subcontracting text input, since subcontractors do not need special equipment. Other batch methods include the various keyboard-to-magnetic or paper tape, cartridges, cassettes, and diskettes. A special reader for the method used is required on the computer to read-in the recorded text. This method is not as flexible as OCR, and those systems require special typewriters equipped with the recording medium. The error rate of OCR is a concern since it adds correction time to the edit cycle. This could offset any advantage over keyboard to tape, cassette, cartridge or diskette systems. Error rate along with other factors of cost and quality will form a basis for trade-off analysis of batch methods. Batch text input has one other distinct advantage in that it is not dependent on the computer to function - it is off-line. Computer failure does not disable the input stations. One other technology for batch input, voice recognition, is also currently developing and will be discussed in 3.4.2.5.

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[1] Bialik, Whiting-O'Keefe, Humphrey, Zablocki; "An Initial Study of Current and Projected Publishing Technology Pertinent to the Navy Technical Manual System (NTMS)"; Stanford Research Institute; March 1976.

[2] S. Berkowitz, "Highlights of ADP-Related Technology of Concern to the Navy Technical Manual System," David Taylor Naval Ship Research and Development Center, June 1975.

[3] D. R. Hill, "Navy Technical Manual System Information System Concept," IBM, 31 December 1975.

[4] C. F. Touchton, "Navy Technical Manual System Publishing System Technology Overview," IBM, 31 December 1975.

Interactive Text Input - Interactive text processing is computer dependent, although not the most efficient use of the computer. However, it is a cost-effective method for edit and update of text while batch systems are mostly ineffective. Size of the text processing operation will determine the amount of batch input used, compared to interactive. Small operations (two to six stations) may need to be all interactive (this would include netted or standalone intelligent terminals) because all of the terminals may be needed for edit and update at a particular time. Larger operations can depend on a constant mix of new input, editing and update, and can mix batch and interactive to take advantage of the efficiencies of each.

Automated Graphics Input - There is no mass movement toward automation of graphics processing, although many publications activities are considering automation. Graphic automation also utilizes batch or interactive techniques. The batch input mode in text is always intelligent, since when entered into the computer or computer storage it can later be manipulated by character, word, sentence, etc. Graphics, on the other hand, is most often read in as a total image - one picture that is essentially an unintelligent form. However, there are batch methods that can read in a picture and reduce it to its intelligent form (lines, symbols, alphanumerics) so that it can later be changed interactively. Other batch input involves creating the graphic on an off-line device, recording it on magnetic tape, and reading it into the computer. The off-line systems could be alphanumeric as sometimes used for numerical control (NC) applications or conventional computer graphic CRT, tablet, or digitizer with a magnetic tape output. This latter approach is actually an interactive input method, since some computer processing is needed. The equipments used are the typical computer graphics input and change devices. The CRT with keyboard can be used to input and change, or react with the tablet/menu which also inputs, and in turn also work with the digitizer that selects coordinates for placement of symbols and draws lines, all with computer interaction. These three devices together or in different combinations, with currently available software, can create any type of drawing and then make changes.

Cost Implications - While cost-effectiveness and affordability were a consideration in selecting batch or interactive modes of text processing, cost-effectiveness has been the factor in using graphics or not using it at all. One major deterrent to graphics system development and use has been the relative costs of operation. The systems basically replace the less expensive labor involved in manually preparing graphics with expensive equipment. The expensive labor, the layout-man, must still visualize the drawing into the system. Although providing some drawing parametrics, the labor replaced is that of the lesser skilled inker and letterer. Another factor in the slow implementation is that a one-page graphic can use hundreds of times as much storage as one page of text. This is a size and cost problem in computer core requirements, in working storage in time-share systems, and in archival storage.

3.4.1.5 PRESENT TECHNOLOGY FOR CONTENT CAPTURE (Continued)

Graphics Output - The output devices usable for graphics have had a limited effect on use. The most common graphic output device is the X-Y plotter driven by the computer or by a tape input. The more expensive graphic quality photocomposition or computer output microform (COM) devices can also be used to create graphics. Since photocomposition and COM are also text output devices, text/graphic merges and even entire books could be created digitally in the output device. Currently this is done, but most often it is a combination of digital text and photographic artwork, such as in the TRUMP system, even though the TRUMP output device has the capability to output digitally processed graphics.

Graphics/Text Integration - Graphics automation systems have not had the wide acceptance of text systems. Proliferation of text systems is apparent in all areas of the government and the private sector. However, systems are designed to operate text as a separate entity from graphics even to the extent of performing manual merge (text and art). Graphics is still predominantly a manual process. The implementation of automated graphics for publications is most often connected to the use of computer-aided design (CAD). In CAD systems, graphics for needs other than engineering are either reprocessed engineering drawings or prepared separately from engineering on a lower priority schedule. Automated graphics integrated into a "Publications System" of automated text and automated output (photocomposition or COM) are rare.

Current Trends - Content capture functions in the SYSCOMs, ADPREPS and TRUMP, employ batch and interactive text input methods, but have no graphics automation. Graphics are prepared manually and input into the system as digitized or photographic images, using some manually performed processes.

Content capture technological development has provided the hardware and software to make the transition to automation and to further sophistication of text and, in particular, to graphic processing. The key element is how to do it efficiently and cost-effectively, while reversing the tendency to wait for tomorrow's advances. Generally, for years, there have been no major technological breakthroughs in these technology areas - only refinement. Major changes in technology are not indicated by present research.

3.4.2.1 PROPOSED AND PLANNED NAVY PUBLICATIONS SYSTEMS

Current approaches are leading to refinement of existing systems through multi-stage addition, replacement, or modification of system elements; however, long-range objectives are not yet firm.

Growth into new systems is usually an evolutionary process, going through several stages governed by economy, technology, and organizational/operational factors. This is particularly applicable to the further development of the NAVAIR and NAVSEA automated content capture functions. Probably most apparent, after system design, are the cycles of approval and funding authorization through the various levels of authority. Some organizations have reported that the entire process has taken years to complete. In short, the procurement cycle for the improvement determined and designed this year could be implemented as late as 1980.

Both the TRUMP and ADPREP systems were developed as singular programs with limited incremental follow-on improvements. Although there was long-range planning for the TRUMP system, it dealt more with expanding the system to other areas rather than broadening its capabilities, as is the current situation in NAVAIR. NAVSEA (Code 5600 at NSWSES) is now starting the approval/funding cycles to augment ADPREPs. The following presents the key information obtained during research and discussions on the future of these systems:

The planned NAVAIR growth is from the TRUMP system. Since TRUMP is a powerful automated system, it can be the base for growth - in this case, modification or enhancement. As previously reported, the program has already begun to determine the output of contractors' technical manual data bases. Once determined, the analysis can be made as to how the interface to TRUMP will be designed. Because data could be delivered as typewritten pages, MT/ST cartridges, reels of magnetic tape, paper tape, floppy disks, etc., reading-in and converting for processing is a significant consideration. Alternatively, the conversion to a limited set of input media by the contractor for delivery to the Navy must also be a consideration. This improvement, no matter how approached, will require added input devices and software development.

Another upgrade involves converting the present systems of photographing graphics, and outputting them photographically in the Computer Output Microfilm (COM) device. Conversion to a digitally scanned input and a digitally formed output (as with text) in the COM device is planned. Beyond these improvements an often mentioned area is the potential conversion from roll microfilm to microfiche. If that comes to pass, it can be accomplished with the same basic content capture/output system, requiring a hardware modification to the COM device and software changes to accommodate the layout and construction of the fiche in place of the roll film. The major factor in microform conversion would be the field-deployed equipment for use and storage. There has been a significant investment in the MIARS system which is yet to be amortized. Beyond these near-term system improvements, in the far-term future (where digital data delivered to the user is a potential) the direction NAVAIR is going permits easy evolution.

NAVSEA has also begun its evolutionary process. Although in-depth details of the immediately planned improvement to ADPREPS were not yet available, it was learned that the system proposed contained its own medium-scale central processor; hence, it could be independent from the jointly used computer in Corona, California. It was also learned that the input terminals and output photocomposition device now in use would remain, and sufficient digital storage devices added to handle growth in input and output capabilities. The aim of NAVSEA to also interface to contractors' technical publication data bases requires the same analysis of contractor interfaces as NAVAIR has started for the TRUMP improvement. The cost/effectiveness analysis for NAVAIR would be applicable to NAVSEA in regard to this system enhancement. The planned NAVSEA program has several stages of development: first, the current ADPREPs improvement; second, a jointly sponsored program by NTIPP and SEA03 with SRI to analyze NAVSEA publications requirements and design a system for the near future; and third, NAVSEA is looking to NITPP for the long-range approach.

The current programs in both NAVAIR and NAVSEA address the current needs and existing media but have yet to be sized to projected workloads. The data bank concept implies a need for considerable development in areas of input (particularly batch), in processing and output, in storage, and the related procedural and software areas. Storage of 30 million pages and processing 3 to 4 million each year, a third of which are illustrations, is a considerable requirement for any digital processing and delivery system. Just to expand TRUMP and ADPREPS will only partially satisfy the long range needs of NTIPP content capture functional development. Neither system includes capability for digital processing of graphics, TRUMP was not designed or developed for original text input, neither TRUMP or ADPREPS was structured for inputting large batches of machine readable input, nor have the size and complexity of interfacing their input mode to the contractor's output, or vice versa, to accommodate automated processing been fully addressed. All of these must be considered if internal capability is to be developed to provide total support to the data bank concept.

NAVELEX has not yet begun any internal sophistication, and it was learned that none is planned in the near term. However, NAVELEX could easily join the other SYSCOM improvement programs, tying in to their development for content capture and output requirements of NTIPP for the 1980s.

The Printing Resources and Management Information System (PRMIS) being developed for NPPSO by the NAVSUP R&D activity has some text processing capability in addition to its principal use for management information. It could be used to service SYSCOM technical information needs on a limited basis if colocated with a SYSCOM organization with needs for only text processing.

Although the SYSCOMs pursue separate system approaches, the functional compatibility remains. The evolutionary process they are going through considers both the immediately foreseeable individual requirements and the longer range potential commonality. Immediate attention to standards and controls for content capture automation remains a critical issue, particularly those affecting interfaces between the contractors and the SYSCOMs. Lack of these standards seriously impacts projections for the future.

3.4.2.2 PROPOSED AND PLANNED ARMY AND AIR FORCE PUBLICATIONS SYSTEMS

Advanced planning by the Air Force involves the continuation of centralized control, management, and operation of technical publications through the proposed Automated Technical Order System (ATOS), while the Army Commodity Commands approach automation more cautiously.

The future shows no major effort by the Army to become more sophisticated in publications automation, while the Air Force has an ambitious, long-range program to expand its internal capability to manage and prepare publications. Advances are based on state-of-the-art technology and will evolve from current systems. Available information on Army plans is sketchy.

The Air Force ATOS Program is detailed in a Data Automation Requirement and is a program planned for several phases over a 15-year period, as outlined below.[1]

ATOS is planned to be evolutionary, building from the current development of the AUTOTEC to produce and update internal publications including technical orders, work cards, indexes and lists of various types. The plan also adds capability for management control of the requirement for providing correct, timely technical data to users, and builds toward a digital data base of all technical publications. Details of ATOS objectives in the first phase of the program are provided in Table 3-XXVII. Subsequent phases of the program will be planned as part of current phase. During Phase I, preliminary study and design for Phase II will be accomplished. The studies will consist of reviews of the latest state-of-the-art developments and contractor consultations. Plan requirements will be prepared when Phase I has progressed enough to allow design of the next phase. This process will be repeated for subsequent phases. Some of the expressed long-range objectives desired for ATOS include the following:

1. Development of an automated on-line, rapid-access system for storage and retrieval of TOs (text and graphics) which will be capable of immediate remote CRT display to authorized field activities.
2. Design of a computer program to rapidly identify data necessary to answer inquiries by individuals to accomplish maintenance. The system would include rugged transportable viewing equipment and transmission capability to such activities as the flight line.
3. Later phases will research and develop a system which will provide adequate secure transmission (satellite or relay) for world-wide capability.
4. Capability will be developed to provide diagnostic data assistance in the simplest form feasible, so the needed data can be automatically presented to a specialized repair activity.

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[1] "Air Force Automated Technical Order System (ATOS) Data Automation Requirement (DAR) DAR LOG-MMO-D75-54;" USAF Technical Order System Branch/MMEDU, Tinker AFB, OK; 28 February 1975, Revised 14 May 1976.

The ATOS DAR presents three alternatives to Phase I of the program. The first alternative is to continue the current system (AUTOTEC and contractor support), the second employs the Automated Input and Document Update System (AIDUS) which is essentially the same as NAVAIR's TRUMP, and the third alternative is a custom-designed system. Approval and funding of ATOS has been requested but has not been received to date. The latest information received indicates ATOS is presently being held in abeyance with no stated reason. Therefore, the planned start in 1977 is delayed. When it gets started and with what alternative approach is now an unknown.

In contrast to the ambitious USAF ATOS program, the Army has no announced programs for improving their present content capture automated systems. The Commodity Commands without the Astrocomp systems will likely acquire them, or something similar. Since the Army does considerable updating of contractor data, it may well be considering the contractor/Army machine-readable data interface. The emphasis in the Army Maintenance Management Center (the central control organization for technical publications) is on product improvement - form and format - not content capture methods and techniques.

Many of the objectives of the Air Force ATOS are presented in the Content Capture topics directly related to the Navy. The need to develop graphic capability in the total system, the need to standardize in the automated areas among each service and contractors, the need for mass storage development and near real-time access to stored data are all common expressed needs of the Navy. They are, or will be, to the Army as well when they have a centralized program to pursue this type of advancement. Much of what all three services are doing and planning will parallel each other since the functional aspects of content capture and the general operational approaches tend to parallel each other.

TABLE 3-XXVII. ATOS PROGRAM OBJECTIVES

OBJECTIVE 1 - Obtain and install large-scale Automated Data Processing Equipment for real-time inter-ALC TO management and preparation of technical publications. Mass storage must be provided for near real-time storage and retrieval of 10M pages of text and graphics.
OBJECTIVE 2 - To resolve design for storage, retrieval, and update of graphics and obtain equipment. The resolvement of this objective will have a major influence upon remaining tasks. A system that can store graphics so they would be available for an on-line system is a primary factor.
OBJECTIVE 3 - To resolve design and obtain general-purpose optical character reader(s) for text and graphics data capture.

3.4.2.2 PROPOSED AND PLANNED ARMY AND AIR FORCE PUBLICATIONS SYSTEMS (Continued)

TABLE 3-XXVII. ATOS PROGRAM OBJECTIVES (Continued)

OBJECTIVE 4 - Obtain modern photocomposer and automatic plate maker. Present in-house equipment produces printer-ready negatives of excellent quality and would be used for initial implementation of AUTOTEC; however, volume, graphic preparation and storage difficulties, and output requirements necessitate that it be replaced with a modern photocomposer that will provide output as photolithics (hard copy), negatives, microfiche, 16mm, and 35mm microfilm.

OBJECTIVE 5 - Further develop and implement AUTOTEC. One of the most important developments could be to standardize codes/formats and graphic media between industry and Air Force. (Codes and formats can only be firmly standardized as in-house and industry systems are fully developed. Text data will lend itself to standardization earlier than graphics because of equipment limitations.) Area of standardization could be extended to other services because of Inter-Service Support.

OBJECTIVE 6 - To further develop and implement preparation of Illustrated Parts Breakdown Manuals (IPBs). Revisions to this program would primarily be concerned with a global change capability and a more extensive contractor interface of systems.

OBJECTIVE 7 - Internal Management is extremely important. Also, redesign and enhancement of our present G022 SYSTEM that produces our TO indexes and all associated TO System Management Data.

OBJECTIVE 8 - Develop a subsystem for reporting advance TO SYSTEM needed improvements, status, and accomplishments. Approved changes, with target dates and other data, would be available to management at all levels.

OBJECTIVE 9 - Develop a Subsystem whereby TO Managers could obtain any and all data related to a TO or various TO groupings. Special one-time information required by management at all levels could be obtained using this subsystem.

OBJECTIVE 10 - To redesign and enhance current system for preparation of Abbreviated TOs in the D069 Program. New D069 programs will be developed and existing publications will be converted. Update could be accomplished on-line via CRT.

3.4.2.3 OTHER PROPOSED AND PLANNED PUBLICATIONS SYSTEMS

While many government and industry entities are largely pursuing conservative approaches to content capture systems, the National Science Foundation approach is ambitious and future-oriented.

Apart from the National Science Foundation (NSF), nonmilitary activities are tailoring individual approaches to satisfy their forecasted needs, using today's technology, keeping an eye on some technology advances, and to some extent anticipating others.

A conservative approach is being taken by the Department of Agriculture (USDA) where a task force on photocomposition has prepared and issued a July 1976 technical specification for the USDA future internal system[1]. The recommended system will provide 18 separate organizations within USDA with content capture functions through a common system. The input methods required specify optical character recognition (OCR) devices, magnetic tape transports (readers), and CRT terminals. This provides both batch (off-line) and interactive (on-line) input capability. The output requirements specify magnetic tape transports (read/write), graphic-quality impact printers, and photocomposition. Between input and output will be a medium-scale central processor and storage capable of storing and manipulating 12 million characters of text. (The system does not accommodate graphics processing.) Extensive software for processing, edit, update, format, and system management has also been specified. The system will be a start at unifying a diverse organization insofar as content capture and output are concerned.

Diversity can also describe a proposed scheme to net the scientific research community together. Universities and research agencies around the country would be part of an "electronic journal" system managed through a central organization such as the NSF Office of Scientific Information Service. (See Figures 3-30 and 3-31.) One such system proposal, prepared for NSF, utilizes some unique approaches that could impact NTIPP[2]. The system uses proven and emerging technology, and is slated for the 1980-1990 time frame. The system structures medium-scale computers at locations around the country, netted to a host computer at the central location. Each location could have one or more computers, each with dozens of subscribers or users with capability to work from interactive terminals to their computer, and with communications capability to the host or other regional computers and their users. The entire system would be netted using both land-line and telecommunications links. The system provides several services to users. It would be used as a text processing device by subscribers providing a full range of input, edit, and output processing. It would also interact with a literature data base to allow browsing, retrospect searching, commentaries, user scratch pads and

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[1] Task Force on Photocomposition, "Task Force Report on Photocomposition in USDA," United States Department of Agriculture, 29 July 1976.

[2] Senders, Anderson, Hecht; "Scientific Publications Systems - An Analysis of Past, Present and Future Methods of Scientific Communication," Toronto University, June 1975.

filing systems; it would provide capability for intercommunications among users; distribute scientific data to users; and even publicize items like RFP's, meetings, and conferences. The basic approach of using a distributed computer network lends itself to a variety of functions, and new applications would be easy to implement, fulfilling one of the main system requirements - flexibility.

The Department of Commerce, Bureau of the Census are developing conservatively, with no major changes evident. The principal effort appears to be a continuation of the integration of the content capture/output functions into their automated data base of census information.

Some of the proposed changes in the private sector were reported in the SRI technology survey[1]. Beyond those, the areas surveyed are not seriously considering revolutionary change, but only refinements and additions to the existing system. For those not yet automated, however, many appear ready to automate. The pace of new implementations will quicken, the choice of systems and equipment will broaden, and economics rather than available technology will continue to drive the advances.

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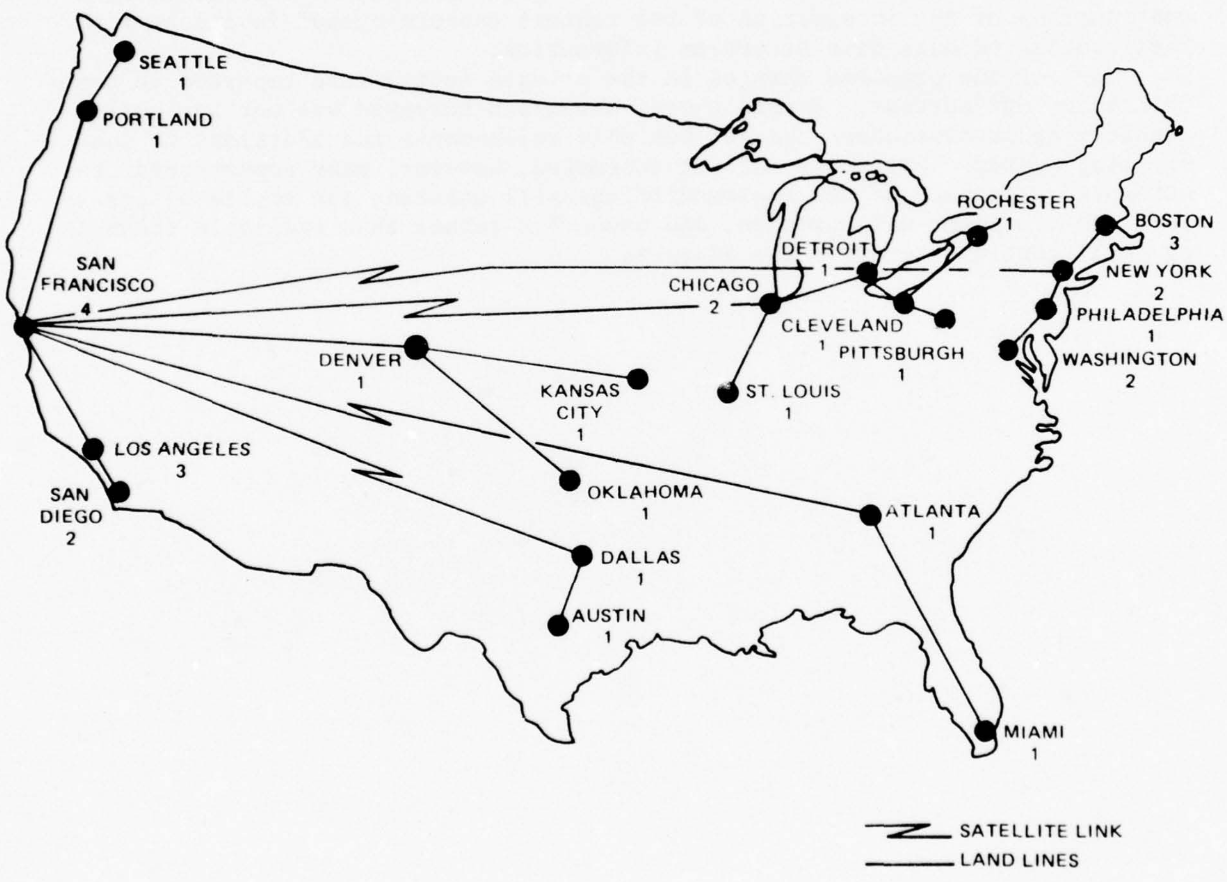
[1] Bialik, Whiting-O'Keefe, Humphrey, Zablocki; "An Initial Study of Current and Projected Publishing Technology Pertinent to the Navy Technical Manual System (NTMS);" Stanford Research Institute, March 1976.



A POSSIBLE TELECOMMUNICATIONS NETWORK FOR THE 40,000 PAGE ELECTRONIC JOURNAL
(THE NUMBER BY EACH CITY INDICATES THE NUMBER OF LOCAL COMPUTERS)

Figure 3-30. One of National Science Foundation Approaches to the "Electronic Journal." Users would be interactive to local computer, to other locals, and to a "host" central facility.

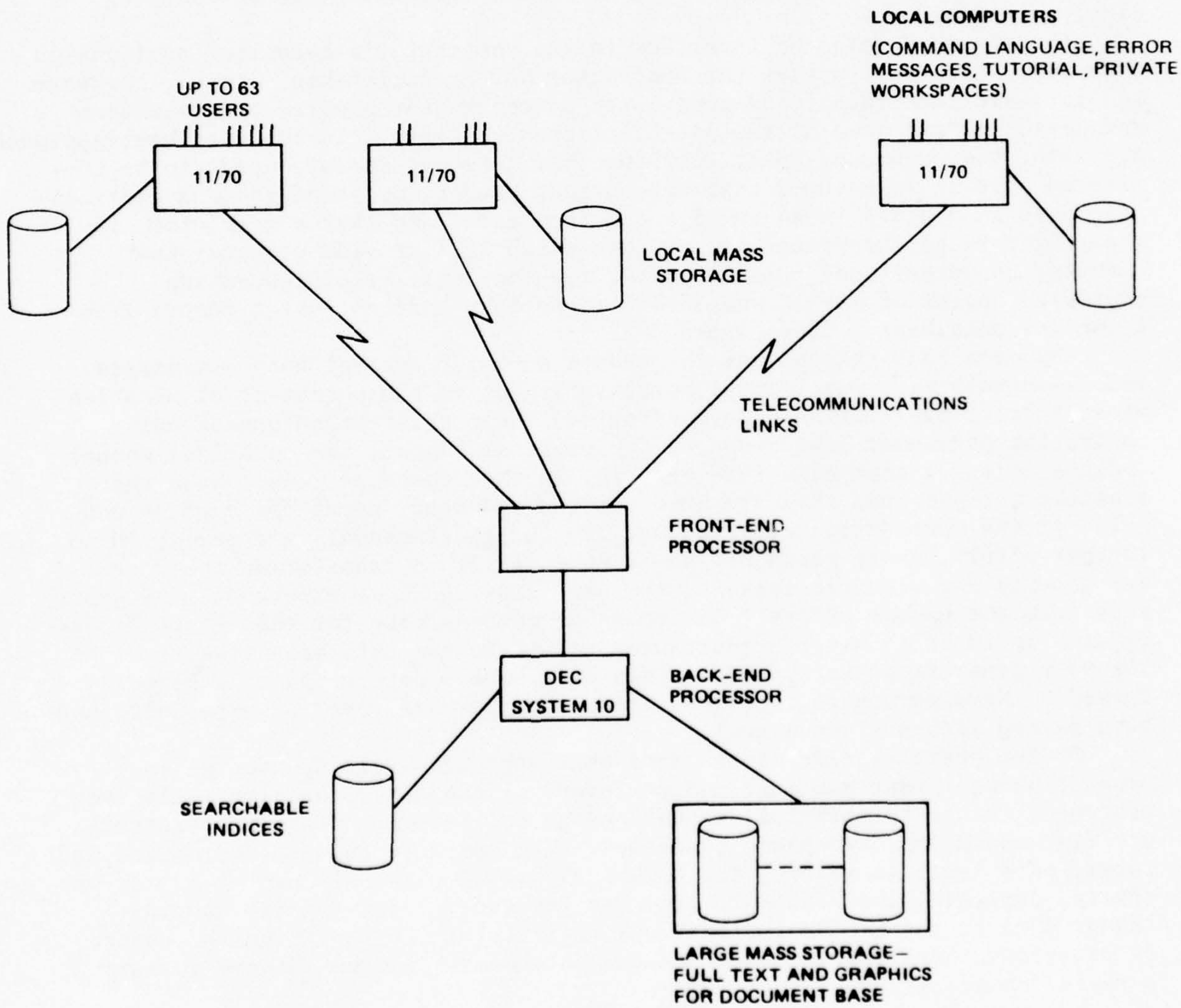


Figure 3-31. Basic Configuration for the 40,000-Page Electronic Journal. (Based on today's technology.)

3.4.2.4 PROPOSED CHANGES TO CONTRACTOR/NAVY INTERFACES

Continuity of contractor and Navy publications interface through the contractor support life of a system is impacted by the SYSCOM's considered alternatives to perform all update internally, using a common contractor/Navy technical publications data bank.

The concept of establishing and maintaining a technical publications data bank at the SYSCOM publications activities (or other central locations) is a worthwhile goal, particularly in regard to the future digital world being widely discussed.

The aim to develop an interface to the contractor's technical publication data base, however, impacts the contractor/Navy relationship. Costs, hardware and software interfaces, and continuity of contractor program organizations and personnel are some of the potential problem areas. In the data bank approach, approach, the nature of specifications, for form and format, needs to be considered. If it is assumed that the current problem of standards and controls discussed in 3.4.1.4 is an immediate action item, and that a resolution for the longer range interfaces is possible which will provide computer-to-computer conversational compatibility, the focus can be placed on the expressed desire of NAVAIR and NAVSEA to perform updates in the future from a central data bank. (See Figure 3-32.)

The data bank concept and the update approach present both advantages and disadvantages. One initial negative aspect is the potential elimination of contractor publication update efforts. The present technique of using contractor personnel (who prepared the original manual) for technical manual updates offers a cost-effective feature, in that those personnel have the greatest insight into the data base changes and other needs for a given manual. If the contractor delivered only the original manual, and performed no further effort, those personnel would necessarily be transferred to other assignments for economic reasons, thereby removing their experience and expertise from the update effort. One means of compensating for this loss of continuity would be to use the contractor to update the data bank itself, with the Navy generating the updates. This data bank update could also be performed by Navy personnel, but only after a comparable level of experience had been gained with a given manual.

On the positive side of the data bank approach (with updates of in-production equipment publications performed by the Navy) the time cycle from equipment change to technical manual change is improved. Many procurements are time-consuming, two-phase processes. The hardware change is procured and later, as a separate effort, the technical manual change is procured. In the revised approach, the SYSCOM Program Manager can furnish the engineering change data to the SYSCOM publications activity at the same time the change is procured, where the technical manual data bank would be changed to output a revised publication.

Perhaps the most difficult situation develops when dozens of contractor technical information data banks, particularly digital, are to be interfaced to one or two central Navy processing systems. The most apparent problems are the wide varieties of computer coding (ASCII, EBCDIC, etc.), the different

processing codes, and the different interface media. There are processing codes structured for each different system employed for content capture, processing codes for input of data, and different codes for output of data. The diversity of digital tape (7-Track, 9-Track, cartridges, cassettes, etc.), paper tape, disks and diskettes, all customized to their systems, present a substantial problem that is, however, technologically solvable. Mixing non-automated and automated inputs to the Navy is not a serious problem. Manually prepared technical publications can be entered into the data bank via OCR and graphics digitally scanned into the system.

The total picture focuses on the cost to provide the compatible interface between the Navy system(s) and the contractor's systems. It is recognized that the Navy will have to bear the cost of providing the conversion capability at its facilities, or to pay the contractor to convert to a specified form for input to the data bank. This cost must be determined. The problem is just beginning to be sized by NAVAIR, and its results will relate to others with the same approach to content capture.

An additional aspect of the data bank concept is the need for contractors to also maintain a data bank. Support of other customers having modified versions of the hardware is one reason for the contractor to retain the data base. Care is needed to maintain integrity when a redundant data base exists. Once the original data base is furnished to the Navy, the chance of that data base matching the contractor's is questionable unless both are maintained (updated) by the contractor or the Navy, but not by both.

It should be pointed out that NAVSEA's ADPREPS does not accommodate the data bank concept and NAVAIR's TRUMP in its present form is but a partial implementation with the TRUMP expansion plans, if realized, providing a somewhat fuller implementation of the concept. Total implementation requires considerable analysis and development of the contractor's data bases and the interfaces needed to transfer them. A separate comprehensive study beyond that conducted by NAVAIR in recent months is needed to determine not only the above, but the contractor data base availability, added requirements for data base use and management, relative cost and time factors, and level and extent of practical implementation.

With all the pros and cons, the data bank concept appears to be the wave of the future. It is a sound concept supported by other research such as that by the National Science Foundation in their "Electronic Journal," and the Air Force ATOS. Design and implementation present the challenges.

3.4.2.4 PROPOSED CHANGES TO CONTRACTOR/NAVY INTERFACES (Continued)

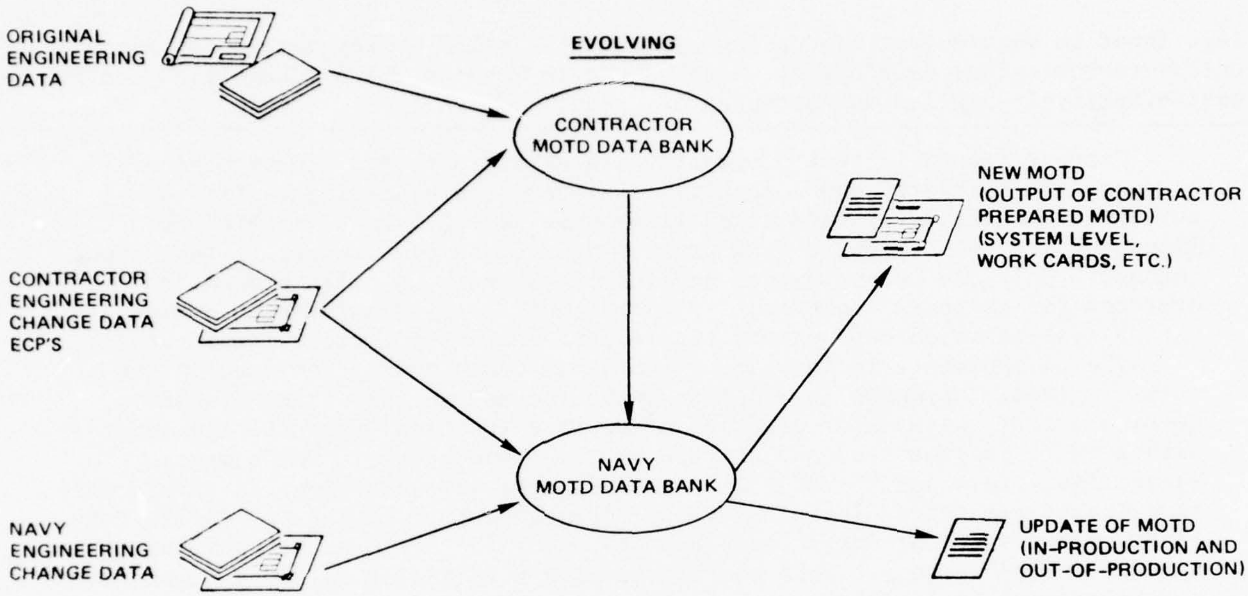


Figure 3-32. Evolution of the TM Data Bank. Change processing can be streamlined, but problems to the contractor could emerge.

3.4.2.5 TECHNOLOGY: TEXT INPUT METHODS

Text input in future text processing systems will still be keyboard-constrained unless technological developments such as man-to-machine voice recognition can be cost-effectively applied and accepted by users.

Current trends in text processing are directed toward improvement of hardware and software, and competitive influences are driving costs down. Surveys of manufacturers and other literature searches have revealed no impending radical change to text processing and, in particular, to text input methods. Only one technological development appears to offer a means to overcome the keyboard constraint of text input - man-to-machine voice recognition systems which demonstrate significant increases in text input rates.

The advancements in keyboard systems have been most pronounced in the software area. Hardware developments have focused on the visual display terminals (VDT) with paper printout a separate function. The VDT and printer, with a built-in processor and storage system (tape or diskette) comprise the "intelligent terminal." VDT's are also becoming most prevalent in interactive time-shared (or shared logic) systems. The concept of having one device for input and another for output has been the major factor in doubling input speeds in recent years. This was not so much a technological advancement as an operational improvement.

Present and planned improvements involving computer software have been significant. In addition to formatting, hyphenation, justification, and all manner of copy manipulation, the software provides automatic tables of content, lists of illustrations, and some levels of indexing. The software refinements are a continuing process, and we can look for further improvements, without substantial change to hardware.

Software refinement is also the byword for batch text input methods. Keyboard-to-recording media devices are following the developments of the other keyboard terminals, principally adding VDT in place of type-to-paper for operation. (Incidentally, hot metal linotype and some cold type replacements for use by "typesetters" now use blind keyboard. There is no way to see what is recorded, which is theoretically a sound approach for inputting, but not accepted by operators beyond the typesetters' community.) The optical character recognition input devices, which are essentially a part of a key entry system, are also in the refinement and improvement mode, with expectations of increasing input speeds and providing more cost-effective methods of adding the capability to read a variety of type fonts. The less expensive systems are capable of reading one or two fonts; the demand is for more capability at a low cost, and for the user to be able to add special fonts as they appear. This latter feature is available only in a very limited number of expensive systems.

The one potential technological change to text input observed in NTIPP research is man-to-machine voice recognition. A great deal of research is ongoing in this field, with NTIPP literature searches turning up dozens of recent publications on the subject; at least 10 of these have significance to text input for publications. Most research has been directed toward control devices and simple information response applications. Extrapolation of the data from this research into the content capture context presents some

interesting factors. As seen in Table 3-XXVIII, the rate of voice input can be three times greater than the most commonly used handwriting/typed input. Handwriting to voice input is at least as fast as handwriting to typed input.

Consideration of voice regonition as a viable alternative to other batch input methods (OCR and keyboard-to-recording media), is many years off. Full potential of the other methods has still to be realized. However, development of voice recognition systems should be instituted. Current systems are developing increased vocabularies of thousands of words but more work is needed in the area of syntax and computer understanding of technical information structure. Attention must also be directed toward methods of inputting tapes of dictated data at high speeds into the computer. A program of investigation and test of the technique is needed to determine user acceptance. This concept is essentially dictating, but for a machine to read rather than a typist. The same human factors that have impacted the implementation of dictating equipment may apply here. Such things as ability to dictate, desire to dictate, self-confidence and convenience factors have been the reasons conventional dictation is not more widespread. One of the factors not present in current dictation methods, that may influence more acceptance, is that no human is in the loop to read the dictated input. The originator could get the initial capture of his input returned to him.

With no other text technological breakthrough on the horizon, voice recognition needs consideration. It offers a potential cost effectiveness that should not be ignored.

TABLE 3-XXVIII. FEASIBILITY OF VOICE RECOGNITION SYSTEM
(THROUGHPUT PACING FACTOR)

Initial Input to System
(Words/Second)

	Handwriting	Oral	Typing	Time to Input 100 Words
1. Handwritten/ Typed	0.38-0.42	-	1.6-2.5	5.0 minutes
2. Writer Typing	*	-	0.2-0.4	5.0 minutes
3. Dictating/ Typed	*	2.1-2.8	0.8-1.3**	2.3 minutes
4. Handwritten/ Voice Input	0.38-0.42	2.1-2.8	-	5.0 minutes
5. Voice Input (Dictating)	*	0.8-1.2***	-	1.7 minutes

*Assume some relative amount of handwriting
**Typing from dictated input assumed to be one-half the speed of typing from copy
***Assumed to be 50-70 words per minute

3.4.2.6 TECHNOLOGY: GRAPHICS HANDLING METHODS

Advances in the state-of-the-art for automated graphics processing may be needed to adequately serve potential users for dedicated technical publications systems. Inquiry into the need for conventional symbols in diagrams is also in order.

Graphics automation is an emerging technology. Development has not been as rapid as in text processing, and applications to technical publication content capture need attention. Most automated text systems are still handicapped by the lack of similar sophistication for graphics. Publications systems will not become total systems until graphics are automated and mergeable with text in the output device.

The automation of "graphics" has followed the development of computer-aided design and manufacturing (CAD-CAM) systems. Of those contacted during NTIPP research who have little or no CAD-CAM, the unanimous position was that CAD-CAM was needed and wanted. However, the initial capital investment of several hundreds of thousands of dollars has been a deterrent. This technology is tending to further develop assistance to engineers such as the ability to perform analysis (of circuits, of stress, etc.), run diagnostics, and to use the system as an artist's or draftsman's tool, as costs come down. The projection to the future shows the need to develop an interface from CAD-CAM applications to automation of graphics for publications so that such systems would provide the ability to pick up engineering drawings as well as create publications graphics in digital form. It would also distribute the cost of implementation and operation to affordable levels for all users in small operations, since only the very large operations can approach being cost-effective with separate dedicated systems in engineering and publications.

Automated illustration systems developed for publication graphics are usually based on the CAD/CAM technology using vector plot principals. In these systems the image is created by connecting a series of incremental vector points together that, when in a row, make a line. In basic operation, the automated illustration system functions as the computer aided design system with programs structured for the desired end product, such as diagrams or mechanical drawings. Since the automated illustration system needs to interface with automated text processing systems and output devices using TV raster scan principles, that interface must accommodate integration of the vector plotted graphics for output with the text.

Still needed in automated graphics is a solution to the need for large amounts of core and storage. Techniques for digital compression are expected to alleviate the problem. These techniques take the basic structure of a digitized graphic (a matrix of tens of thousands of points, some with and some without a signal, where those with signals comprise the graphic image as would be seen on the face of a cathode-ray tube), and compress some of them. For example, if 500 points in a row have a signal, the computer may read and record them as one point connected to another point X number of points away. Such savings in storage become very significant. However, another approach to the problem needs further investigation and development.

For diagrams which comprise over 60 percent of the graphics in most technical publications, it can be postulated that there is no need for symbols. The diagrams, for the most part, can be constructed in alphanumerics without the standard symbols for diodes, gates, valves, switches, etc. Even boxes on some block diagrams could be eliminated. That being the case, a diagram could then be constructed on a typewriter using alphanumerics, dashes and dots. Since storage of alphanumerics uses hundreds of times fewer bits of storage, the storage problem greatly diminishes. Mechanical drawings would be more difficult to construct in the same manner without special keys on the input device. The technique is not new, having been successfully applied several years ago to logic mechanization diagrams. (See Figure 3-33.) The computer was taught how to "draw" the diagram on a standard computer line printer from the logic equation, input/output lists, and signal data.

Elimination of symbols from a diagram might have a deleterious effect on comprehension since the pure visual recognition of a symbol is an immediate rote response. Having to read the alphanumeric representation of the symbol requires a slower conscious mental act. An example of this is that, to a trained electronic technician, a sawtooth line is immediately recognizable as a resistor. If it were not present he would have to read "R-6" to determine what it was. However, since the "R-6" is present with the sawtooth line and since he may have to read it at some point anyway, an argument develops for elimination of symbols. Learning methods and other human factors elements will need to be studied if the concept of symbol-less diagrams is considered.

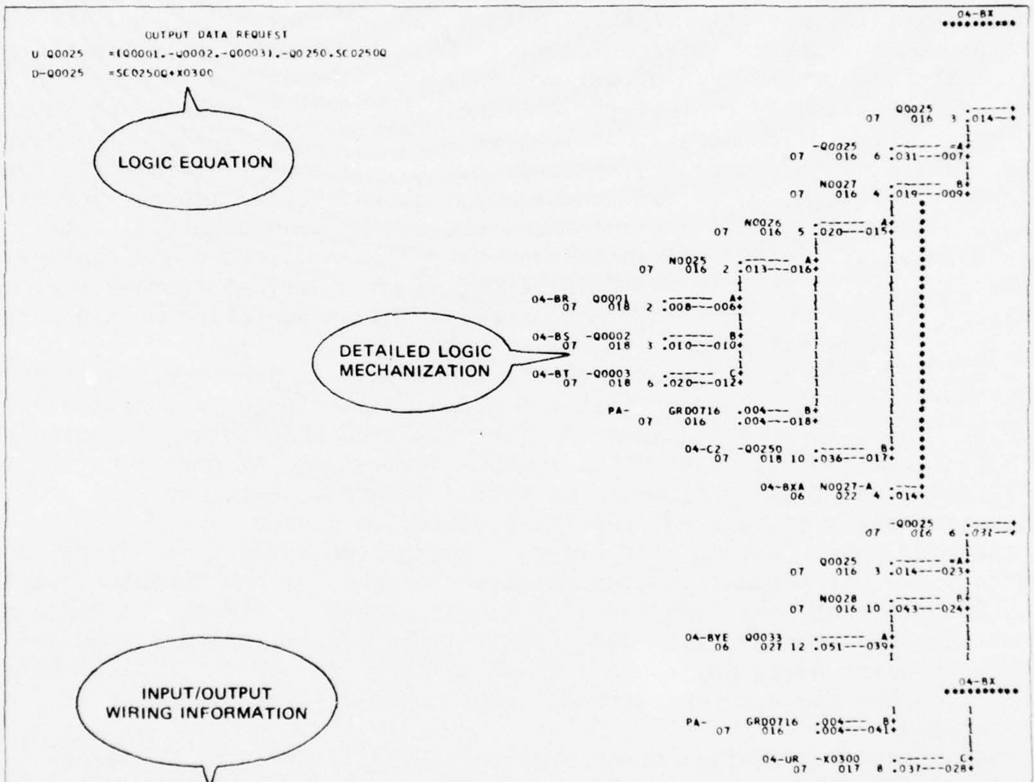
As discussed above, using data compaction techniques can reduce storage needed for graphics. Some techniques can reduce requirements by as much as 90 percent. Predominately a software problem, its application to the graphics that will ultimately be merged with text is essential. Data bank concepts, if they are to be all digital, will have very large storage requirements and without compression of graphics, digital storage, even with emerging mass storage methods, would be of questionable cost effectiveness. Combined digital and film or all film with conversion to digital are alternatives that would need consideration.

There are other factors pertaining to the development of dedicated technical publications automated illustration systems such as input and output method, use of color, size constraints, halftone processing and text and graphic merge. The input and output methods and text and graphic merge were discussed in 3.4.1.5. Size, color, and halftone all present problems to automated systems. All are technologically solvable, but usually at greater cost due to added handling or processing. Most automated graphic systems are size constrained by their input/output devices with output being the most significant. If a graphic output is to merge with text in an automated output system such as COM or photocomposition, then 8-1/2 x 11 (or increments of 8-1/2 x 11) is the most cost effective size. Beyond that, except as incremented into 8-1/2 x 11 parts as in some microforms, larger sizes are impractical due to current limits of the output devices. Color can be handled in automated graphics, but again it is special handling and more costly to process. This could be a limitation affecting a presentation method such as FOMM

3.4.2.6 TECHNOLOGY: GRAPHICS HANDLING METHODS (Continued)

or the Army's ITDT. Halftone processing, although a technological practicality, hasn't been fully developed for automated systems. The cost is also a factor here along with a question of need since they are being phased out of the microformed MOTD with no apparent problem. Also, unlike the various types of line graphics, which can be created in an automated system, the halftone is created elsewhere (usually a photograph) and then input (scanned), processed, and output in the automated graphic system. Halftones could be the only data that would require special handling in an automated text/graphic system if they are used.

There is still a ways to go before automated graphics processing becomes as widely accepted as automated text processing. However, automated graphics processing is an integral part of the emerging automated publications needs, which is important to NTIPP, and its development will be driven by demand created by acceptance and use.



SIGNAL SOURCE	PAGE	SIGNAL DEST.	FROM CC-TP	SA-SA	SG	CL	NO.	PIN	S	TO CC-TP	PHU	SA-SA	SG	CL	NO.	PIN
N0025		A N0026	G2-02	07		J	016	013	S	G2-05	085	07		J	016	016
N0026		A N0027	G2-05	07		J	016	020	S	G2-04	085	07		J	016	015
N0026	04-C2	=S Q0250	G2-05	07		J	016	020	S	FF-11	085	07		J	018	042
N0027	04-BXA	N0027-A	G2-04	07		J	016	019	S	G1-04	085	06		J	022	014
N0027		B Q0025	G2-04	07		J	016	019	S	G2-03	085	07		J	016	009
N0028		B -Q0025	G2-10	07		J	016	043	S	G2-06	085	07		J	016	024
Q0025	04-BK	=C H0025	G2-06	07		J	016	023			085	05		J	020	006
Q0025		=A -Q0025	G2-03	07		J	016	014	S	G2-06	085	07		J	016	023
-Q0025	04-ZX	=A X3465	G2-06	07		J	016	031	S	G1-01	085	07		J	006	010
-Q0025		=A Q0025	G2-06	07		J	016	031	S	G2-03	085	07		J	016	007

Figure 3-33. Logic Mechanization Created in the Computer. Diagram prepared from the Logic Equation, Signal, and Wiring Information and Output on a Line Printer.

3.4.2.7 TECHNOLOGY: STORAGE AND DELIVERY MEDIA

The publications systems of the future will rely on mass storage methods to accommodate the "explosion" of data needed to support advanced weapon systems. The storage medium and the delivery method are strongly interrelated.

The media in which today's technical information is stored and delivered include microform, magnetic tape, diskettes and, of course, paper. For content capture, the stored information will probably be all-digital in the future. The user could even be delivered digital media in a form he can store, and subsequently convert for his use. Conversion might be to paper, to an interactive video display device, or to some other device. The current hardcopy/microform products and systems will not disappear overnight. Even though the microform, which many consider as an interim medium for DoD organizational maintenance, may in time phase out, the paper medium will remain - but as a secondary medium - created from the primary delivery and storage medium. The key to this is the development of mass digital storage that can be adapted to the technical information media and presentation method determined in user/data match analysis.

A mass storage method, to be usable for technical publications storage and delivery, must accommodate text and graphics in a page-orientation relationship. There is no indication in NTIPP research that future technical information will not be constructed in book form - page by page - rather than free-floating information elements of varied lengths. Retaining the book organization makes storage and retrieval easier to manage.

The most common methods for digital storage (magnetic tape, discs, and diskettes) are not adequate to accommodate the needs of the technical publication inventory at user locations. A single technical manual can contain several thousand pages of text and graphics; the digital storage required for each thousand pages may range from 20 million bits to one billion bits, depending on how the data was stored - alphanumerical (symbolic) or image-scanned.

Developments in storage media are continuing in the area of large-capacity, inexpensive systems. The previously referenced DTNSRDC Highlights of ADP-Related Technology[1], NSF Scientific Publications Systems[2], Stanford Research Institute technology assessment[3], and the recently published DTNSRDC

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[1] S. Berkowitz, "Highlights of ADP-Related Technology of Concern to the Navy Technical Manual System," David Taylor Naval Ship Research and Development Center, June 1975.

[2] Senders, Anderson, Hecht; "Scientific Publications Systems - An Analysis of Past, Present and Future Methods of Scientific Communications," Toronto University, June 1975.

[3] Bialik, Whiting-O'Keefe, Humphrey, Zablocki; "An Initial Study of Current and Projected Publishing Technology Pertinent to the Navy Technical Manual System (NTMS)"; Stanford Research Institute; March 1976.

sponsored Video Disc Technology Assessment[1], collectively present details of storage and delivery media of the future. From these reports and other research, the media showing most promise for NTIPP are depicted in Figure 3-34 and presented below:

The first is the video disc, similar to a 12-inch phonograph record. Each disc contains about 54,000 frames of analog data. A frame could be one frame of a television program (each disc would then contain a 30-minute program). However, since the normal raster scan used for TV images will not provide sufficient detail for a MOTD text or text plus art page, several disc frames of data (as many as four) would be needed to present a page of MOTD. If the ratio is 4 to 1, the video disc would carry 13,500 technical manual pages. The entire publication file of a weapon system could be placed on one or more discs. Initial development has been concentrated on the home entertainment market, but much attention is being received from the Navy, the other services, and the private sector. This media represents a viable media to store and deliver technical information.

Another medium of promise is the hologram. The hologram method considered as viable for NTIPP is a piece of 105 x 148mm film, the same as used for microfiche. In fact, one of the two methods being reported provides both human-readable and machine-readable (HRMR) data on the same film. In this application, it is possible for one fiche to provide up to 98 human-readable microform images, along with a digital representation of those images and additional digital data for identification, retrieval, or other purposes. The same fiche, when only digital data is stored, can hold 30 million bits of digital data or about 700 pages. HRMR is currently being developed by the Air Force, and represents an ideal medium for transition from microfiche to a digital system. The storage media, methods of use, and applications interrelate, so that changeover from microfiche to digital would be less difficult to accomplish.

The Air Force technique in the HRMR program is creating the hologram synthetically, not photographically. However, there are other techniques for creating the conventional photographic hologram for digital storage. One method has been announced with a capability to store 300 million bits or about 7,000 pages (10 times more than HRMR) on one fiche, with the potential of even greater storage capacity. Also promised was a read device in the $500 price range, making the system very attractive along with its low per-bit storage cost.

Both the video disk and holographic storage and delivery methods and equipment need additional study to determine their role, if any, in NTIPP.

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[1] Poe Engineering Services, "Photographic Video Disc Technology Assessment," David Taylor Naval Ship Research and Development Center, October 1976.

3.4.2.7 TECHNOLOGY: STORAGE AND DELIVERY MEDIA (Continued)

Microforms, as storage and delivery media, are currently economical and likely to remain relatively so for the near term. This is one factor that will help perpetuate its use for some time to come. Digital media is approaching competitive economical levels with the attention being given to developing cheap mass storage methods. Before we move into the new media, however, the lessons learned from the microform experience must be considered and applied to the analysis of any new methods and techniques.

A discussion of storage and delivery media should also include the "use" media. As is the case with microforms where the delivered media is "used" on a viewer (optical device), data delivered by digital media must also be converted to an optical device or directly to paper or even a microform. If conversion is to an optical device, many of the same factors that apply to microform viewing also apply here. Resolution, illumination, size, indexing, searching, portability, and user acceptance are among the most prevalent. Development of new media must include full analysis and evaluation of the "use" aspects against these factors. Any full media must address usability and the user's needs and not merely provide the most storage capacity or the fastest retrieval or even the cheapest method.

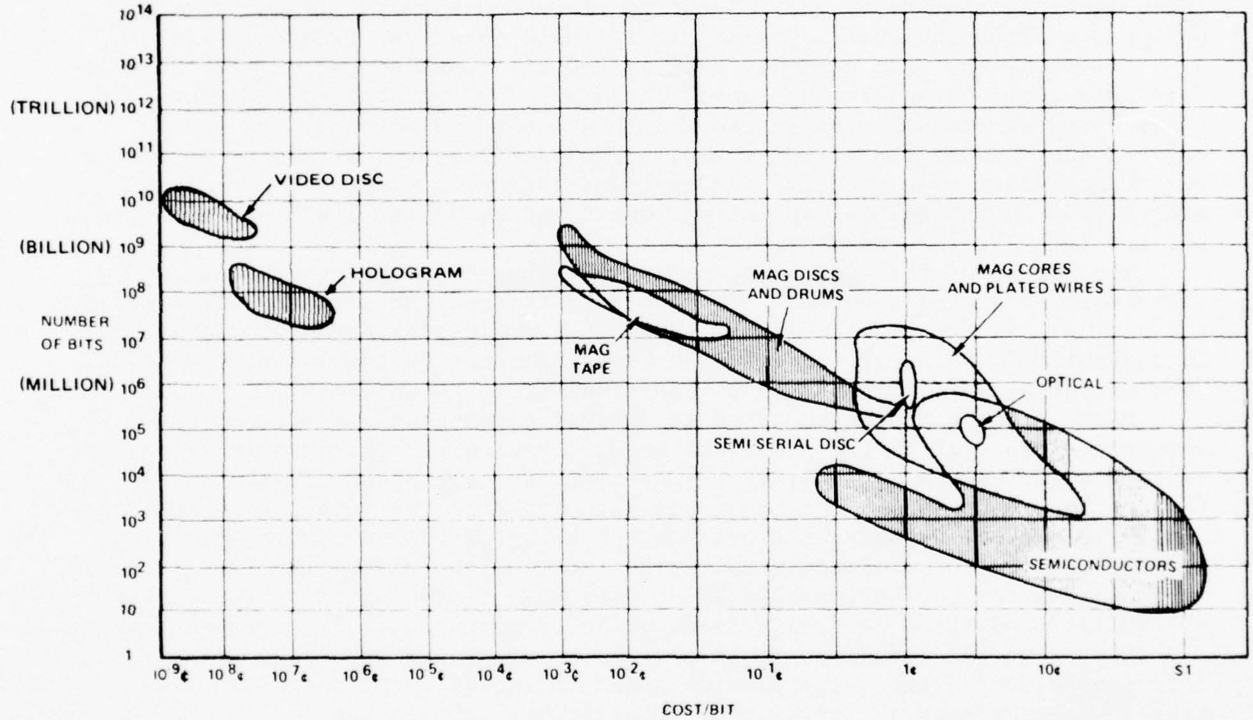

Figure 3-34. Comparative Costs for Future Memory Techniques

3.4.2.8 TECHNOLOGY: COMMUNICATIONS METHODS

Future communications methods to connect the user to his source of technical data must be evaluated on the basis of cost and capability, qualified by a priority system based on need and urgency.

Getting the data to the user is a distribution function but the media created in content capture is often the key to the communications method needed. Since research shows that technical information is likely to be handled, stored, and delivered in digital forms, communications modes must effectively accommodate such digital forms. Factors that govern the mode of communications include urgency, security, form and format. It may take a while to replace the mail, as some digital data forms can even be mailed.

Presently the most commonly used method of communicating digital data is telecommunication landline systems. These are limited to land locations, to their speed of transmission (up to about 9600 baud) since they are mostly voice grade, and to their requirement to convert the digital signal to analog for transmission using modems. Radio transmission is used, but much less extensively. Both point-to-point microwave and satellite links are employed, but are both limited and costly.

Regardless of the mode of transmission, the distributing agencies and users must be netted together. To move data through the networks efficiently, the various components (landlines, satellite, microwave) need to be switched in and out. In this way the data can be transmitted in the fastest manner (for urgent needs) or in the most economical (for routine data).

Much attention is being given to digital communications methods and networks. Since it is the prevalent mode, advances are continually being made in telecommunications technology. These include high-speed digital lines (conversion to analog is not required) with transmission rates up to 100 megabaud, the packet switching network concept being developed commercially, and computer-controlled electronic switching (cutting switching time from several seconds to a few microseconds). These improvements are aimed at increasing reliability and speed of transmission while reducing cost of telecommunicating.

Microwave and satellite links are an improving and expanding area of this technology. These also provide added reliability and speed and reduction in cost as they are developed. However, reliability and dependency on satellites becomes questionable in wartime, when (most authorities agree) they will be prime targets.

Communications developments in millimeter wave and optical transmission (through the air) can provide low-cost distribution of data to a large number of users. Both are low-power devices that operate as line-of-sight (short distances) and can be an effective link in a communication network.

The communications developments in the Navy are most significant. These developments, recently re-confirmed by the Defense Communications Agency (DCA), were very succinctly presented in the previously referenced DTNSRDC Highlights of ADP-Related Technology, which states:[1]

". . . The capability of transmitting technical data to far-flung Navy maintenance activities and to ships is crucial to insure the responsiveness of NTMS (NTIPP) to the fleet. Later this year (1975), the Navy will establish a communications satellite system called Gapfiller, by leasing about 80 percent of Marisat (Maritime Mobile Satellite Communications System); the remaining 20 percent will be available to commercial maritime users. Gapfiller, a two ocean system, is expected to provide greater coverage and capacity than the present joint service tactical satellite (TACSAT) system, and will be used until the Navy's fleet satellite communications (FLTSATCOM) system becomes operational in 1978, at which time almost all Navy ships will be equipped for satellite communications. Automatic switching and cryptographic equipment is being developed for shore stations - local digital message exchange (LDMS) and Naval communication processing and routing (NAVCOMPARS) systems - and afloat - Naval modular automated communications system (NAVMACS). These will interface with defense communications systems being developed by the Defense Communications Agency (DCA). In conjunction with NSA, NRL, and industry, DCA is developing speech compression devices using linear predictive analysis, and is considering the effects of a distributed switching network using mini- or microprocessor firmware instead of centralized hardware switching. All this elaborate and expensive development, however, was not designed for the massive transport of technical text and especially not for communicating graphics . . ."

The significant point is that these Navy developments are not for technical information communications. NTIPP must address its own requirements and define requirements for the distribution system best suited to its needs, whether that be sophisticated telecommunications, microwave, satellite network, or the mail. Technology will not be the driving factor - rather, the decision will be driven by factors of security, need, reliability, urgency, and cost.

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[1] S. Berkowitz, "Highlights of ADP-Related Technology of Concern to the Navy Technical Manual System," David Taylor Naval Ship Research and Development Center, June 1975.

3.4.2.8 TECHNOLOGY: COMMUNICATIONS METHODS (Continued)

TABLE 3-XXIX. CURRENT AND PLANNED COMMUNICATIONS SYSTEMS

Military (Navy)	
GAPFILLER	- interim Navy system using Maritime Mobile Satellite Communications System (MARISAT) is a two ocean satellite system
TACSAT	- current joint service tactical satellite system
FLTSATCOM	- dedicated satellite system to link all Navy ships and other selected installations
AUTODIN/AUTODIN II	- basic telecommunications system
MAIL/HANDCARRY	- people system
Private Sector	
COMSAT	- commercial satellite system
IN-WATTS/OUT-WATTS	- leased line telephone systems
DDD	- Direct Distance Dialing telephone system
TYMNET	- data communications network using telephone systems
U.S. MAIL	- people system

SUBSECTION 3.5
RESEARCH ISSUE 5: CONTENT REPLICATION

3.5.0 DEFINITION AND OBJECTIVES OF CONTENT REPLICATION

The captured content needs to be replicated into paper books, microform, or one of the emerging MOTD delivery media. Replication technology exercises a strong influence on content capture techniques due to the close interface between these two functions.

The replication challenge is to process the output of content capture in the media specified for use. The key words here are "in the media specified," since the media and technology decisions in content capture and replication are mutually dependent. Where and how content is replicated, and by whom, is presently well established but will be greatly impacted by developing media and future applications. Current media is predominantly paper, with growing microform applications. However, microforms appear to be interim media for such as DoD organizational maintenance data inasmuch as digital and other optic methods are developing at a rapid rate and receiving considerable attention as prospective media.

The world of replication in relation to NTIPP is an orderly structure with well-defined products and processes and reasonable controls through specifications and contracts. Contractor-to-Navy interfaces are also established, with the principal interfaces being through the preparation of content capture output to the specified form for replication, and the preparation of a printing order with repro assembly sheet.

Replication of paper media basically involves the conventional printing process and limited quantity reproduction processes. Printing typically involves making a printing plate from the original (master or repro), the press operation, and bindery processes such as collating, drilling, and the actual binding (staple, fastener, etc.) of the book. Of these processes, the plate-making has and is receiving more benefit from technological advances. An example of this is the presently developing laser plate-making systems that can create a printing plate with a laser device driven by a digital tape of the data to be replicated. Automation has been evident for many years, particularly in newspapers where (after plate installation on presses) the newspaper is printed, collated, folded, and stacked for delivery in one operational sequence.

Reproduction processes could be best described by the common term "Xerox copy." There are several methods using combinations of chemical, light, and electrostatic means to make copies direct from an original. There has been some automation of these devices in both automatic feed and collation, making it easier to produce more copies of larger documents. However, the efficiency of this type of machine lies in its use for limited copies of small documents and in an on-demand type environment. The printing process is most efficient for large numbers of copies, but has a long cycle time. Paper media has been around a long time, and will continue to be used for the foreseeable future. However, it may become a secondary media output from other media, as previously discussed.

Microform media replication is a limited technology application. Microforms are currently replicated with one of three processes, silver halide, vesicular, or diazo. Silver halide is a conventional photographic/chemical process and is relatively expensive, but provides high quality with archival permanence. Vesicular film is processed with heat and light to develop and fix the image without chemicals, is less expensive than silver halide, and is not archival since high heat levels will destroy the image. Diazo is a light/chemical process that is least expensive and has acceptable quality, but is not a permanent (archival) image. Diazo is the process used in many "blueline" or "blueprint" machines and copies made by this process will fade during prolonged exposure to light. Automation of microform replication has developed devices where the master is fed into a machine that makes the copies, cuts/trims, and assembles (into jackets for some forms) depending on the form.

The most common microforms are 105mm (used for fiche), 35mm (used for aperture cards), and 16mm (used for roll or cartridge operations). Ultrafiche (on 105mm) is used extensively commercially, but not in the military services. Reduction ratios range from 10X for 35mm to over 100X on ultrafiche. The most commonly used is 24X for microfiche and 16mm roll film. Microform media has many applications, and is an economical storage media. For these reasons, it is likely to be around for a long time.

Paper media is conventionally transmitted and used in the same form - paper. Microform is often used in a different form (paper) than it is transmitted (film). The principal advantage of film over paper is in storage of data. Tens of thousands of pages of microformed data can be stored in the space needed for several hundred paper pages. These two factors, conversion to paper for use and providing high density storage, can be duplicated in other media - perhaps more effectively. The other media potentially usable are video disc and holographic techniques, which will be discussed further in 3.5.2.3.

Figures 3-35 and 3-36 show a possible media changeover impact in relation to the Navy mode of operation. The role of those performing replication will undergo changes - perhaps to pick up replication of new media, to encompass on-demand replication at or near the user - and will be integral to NTIPP as it evolves.

As in previous subsections, some added detail on replication, is provided in the discussions in this subsection particularly on technology, to assist the reader not familiar with these technologies in their understanding of the material presented.

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SYSTEMS AND FEASIBILITY TRADEOFF ANALYSES. TASK 1. ANALYSIS OF --ETC(U)
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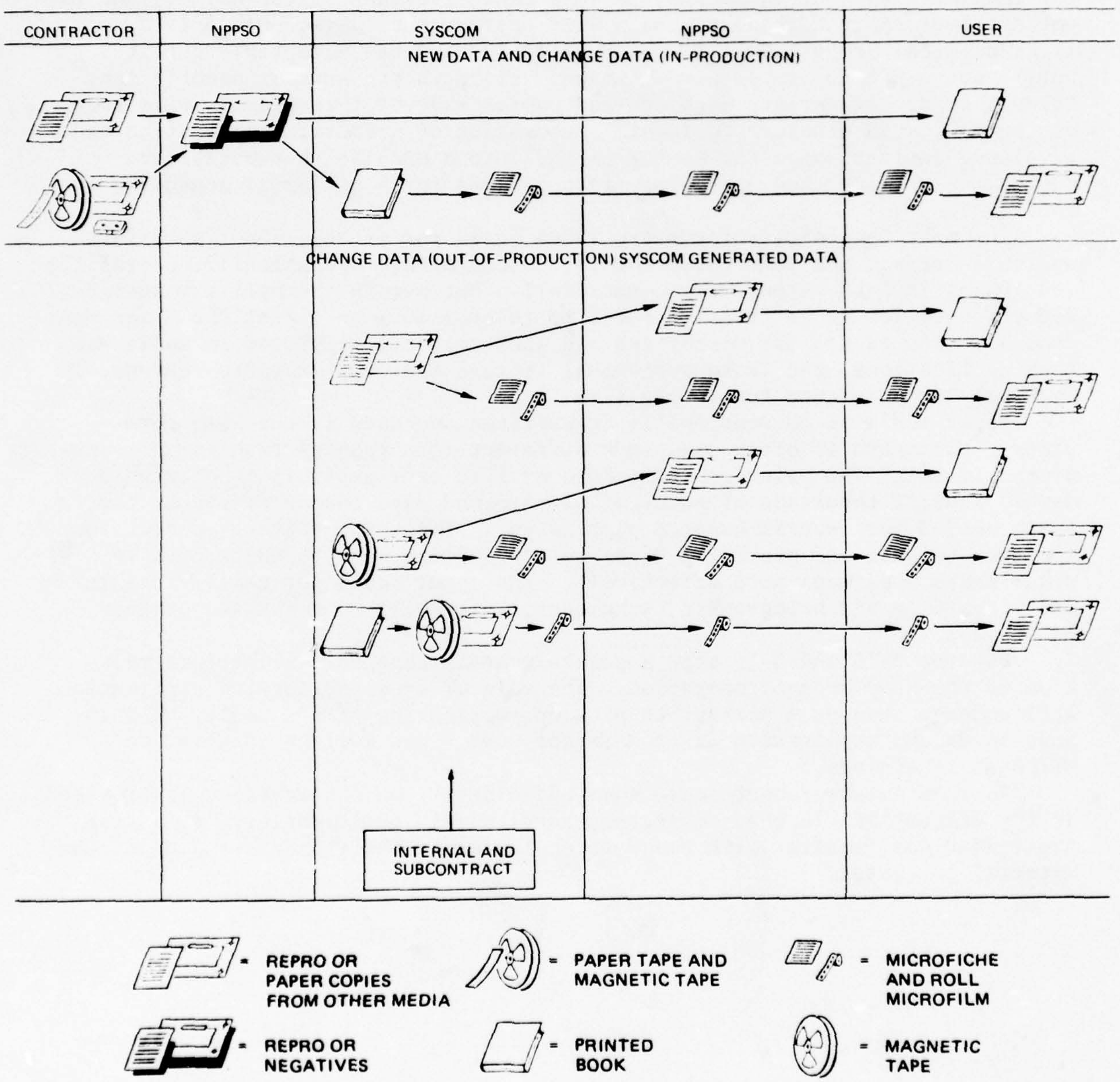

Figure 3-35. Present-Day Flow of Replication Operations. Paper media is an intermediate step and a final-form option in all cases.

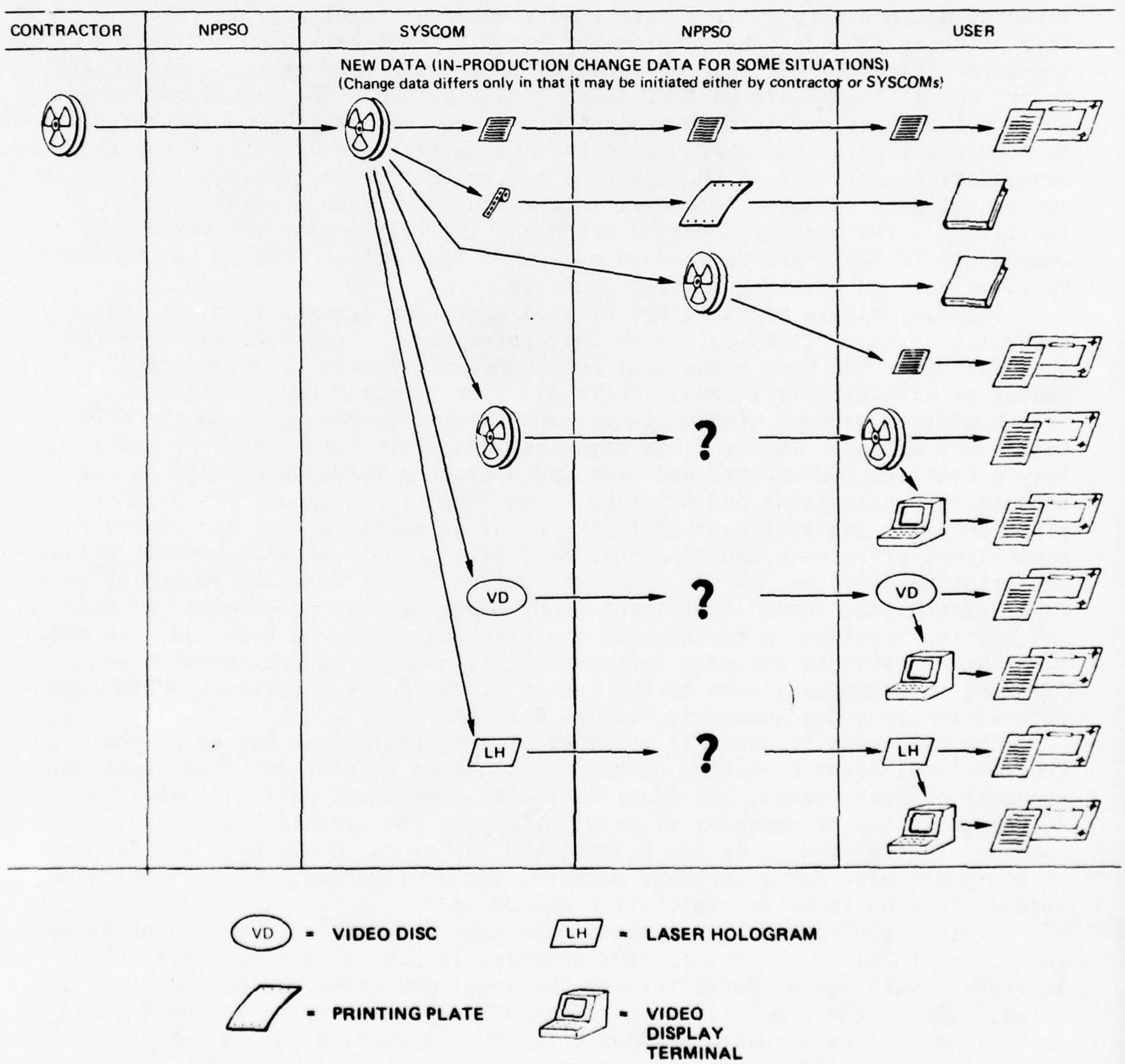

Figure 3-36. Potential Future Flow of Replication Operations. Here, the use of paper is diminished in both the intermediate and final forms.

3.5.1.1 REPLICATION SYSTEMS IN USE IN THE NAVY

A centrally organized capability exists to satisfy the replication needs of the Navy, with an established structure and working within the guidelines of the Joint Committee on Printing (JCP) of the U.S. Congress.

Replication requirements of the Navy range from office duplication of internal documents to large quantity multicolored recruiting literature. Navy printing is under the auspices of The Navy Publications and Printing Services Office (NPPSO). NPPSO operates many major Navy printing facilities, though not all; some are part of other organizations. The annual volume of NPPSO printing is nearly $100 million with more than half being subcontracted to commercial printers. NPPSO also has the charter for all office-copier reproduction equipment in the Navy and has recently been tasked to centralize and consolidate computer-output-microform equipment into several area facilities. The basic charter of NPPSO and the relationship of other Navy components to NPPSO are defined in published regulations[1] issued by the Navy Publications and Printing Policy Committee.

The Navy has in NPPSO an established operating organization with major capabilities in replication, or as they refer to it - reprographics. NPPSO operates under the Navy Industrial Fund, and must manage its production resources within their income. There are over 30 world-wide offices and Branch Offices grouped within six regional Divisions reporting to the NPPS Management Office. Through this organizational structure, NPPSO supports the Navy's District Commandants and Area and Operating Force Commanders on all aspects of publications and printing. The NPPSO field operations develop plans ensuring logistic support in the event of mobilization, and advise on capability, efficiency and readiness to fulfill requirements for publications and printing services. NPPSO provides numerous other services including copyright clearances, issuance of joint (DoD) publications, procurement of writing and editing services, presentations and briefings, etc. as required. In addition, NPPSO provides advisory services on all matters of publications and printing as requested, even to the extent of assigning a resident NPPSO representative in a Headquarters, such as with NAVELEX.

The operation of NPPSO is governed by the regulations issued by the Congressional Joint Committee on Printing. These regulations cover content, production, procurement, and distribution of government publications. The JCP controls the procurement of printing paper; the establishment, use, and closing of government printing plants; and the procurement, use, and disposal of equipment used for government printing and duplicating. The control also extends to some forms of composition equipment.

Another government agency that influences NPPSO is the Government Printing Office (GPO). This occurs, for example, in subcontracting where NPPSO interfaces with and operates through the local GPO structure of suppliers and rates. GPO is the production arm of the JCP, and implements its policy and guidelines. Of particular importance is JCP's directive to use commercial replication capability through subcontract wherever possible. Subcontracting

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[1] Navy Publications and Printing Policy Committee, "Publications and Printing Regulations P-35," Department of the Navy, Revised January 1974.

by NPPSO through GPO to commercial replication services is the principal means of obtaining technical manual paper and microform replication. Paper products are almost exclusively subcontracted, while some microform master preparation and replication capabilities are internal. An example is the NAVSEA microfiche program at Naval Sea Data Support Activity (NSDSA), Port Hueneme, California where the preparation of masters is performed for NSDSA by NPPSBO, Point Mugu.

Capabilities for paper media replication are extensive in NPPSO, as evidenced by the $40 million of output produced internally. The equipment and techniques are conventional, and conversion to new processes or methods is a relatively slow process. High capital investment and relatively slow approval and funding cycles make conversion to new technology difficult.

Capabilities for microform preparation and replication is a comparatively new area for NPPSO, which serves as the Microfilm Project Manager for NAVSUP and participates in the NAVSEA/NAVELEX microfiche programs. One current development is a portable microfiche viewer which will have two prototypes developed for testing in 1977. Since the involvement in microforms has recently become more extensive, NPPSO has the opportunity to install the latest in equipment, as in the case of the NPPSO installation at Port Hueneme to support the NAVSEA microfiche conversion program.

The Navy, compared to the other services and other government organizations, has a unique resident reprographics arm in the Navy Publications and Printing Service.

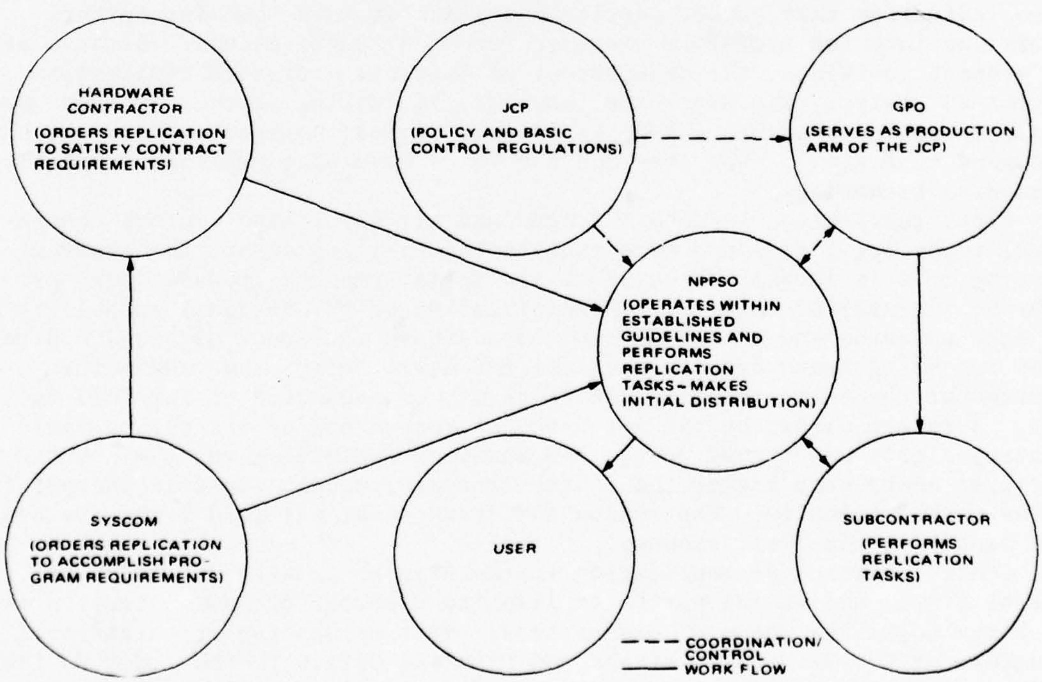

Figure 3-37. Interfaces Between Navy Replication Operations. NPPSO occupies a central role as the Navy's chief control agency for replication.

3.5.1.2 OTHER REPLICATION SYSTEMS IN USE

No essential differences exist in the functional needs for replication of the Army and Air Force from those of the Navy. The replication field is very broad, and satisfies many needs in addition to those of the government and in particular technical data.

The replication requirements of the Army and Air Force, as with the Navy, rely heavily on commercial replication subcontractors since they are also governed by the regulations of the Congressional Joint Committee on Printing (JCP) and do no internal technical publications replication. Technical publications printing is accomplished through one of the Government Printing Office (GPO) Regional Procurement Offices. Since neither the Army or Air Force have extensive technical manual microform programs, their replication requirements are predominantly paper media.

In regard to microform use in other services, the program for the Air Force, Technical Order Microfilm System (TOMS), has been discontinued. Results of trial use of cartridge (roll) microform similar to NAVAIR's MIARS at depot level facilities showed scant advantages, and this program was dropped, along with follow-on programs for other levels of maintenance. Similarly, the Army microfiche program at depot level has been greatly diluted by instructions from the Maintenance Management Center (MMC) to furnish printed books along with the microfiche. This was done when it was found that technicians were making paper copies of the complete data, when only fiche was furnished, and using the paper copies instead of the fiche. There is no indication that either service has plans at this time for further excursions into the microform area for technical publications. Because of the present positions, the development of internal microform replication systems is static. The Air Force, however, is looking at the combined human-readable/machine-readable (HRMR) microfiche/digital hologram method which was discussed in 3.4.2.7. The Army and Air Force have also expressed interest in video disc technology.

Paper replication in both the Army and Air Force also employs conventional technology; although some excellent facilities exist, the internal printing role is largely directed toward forms, reports, regulations, procedures, and similar material. Sophistication of the internal capability has the same approval and funding cycle, in addition to impact of the JCP directives regarding subcontracting, as for the Navy. Also, the continuing requirement for subcontracting limits growth or expansion of internal facilities. A recent effort by the Air Force to reopen one of its closed Field Printing Plants was turned down. The apparent contention was that subcontractors' costs were higher than internal costs, and it would be cheaper to do the work internally. The reason for disapproval was said to be the negative impact on the local economy.

Central control of replication in the Army rests with The Adjutant General (TAG), and in the Air Force with the Director of Administration at Air Force Logistics Command Headquarters. Neither has the organizational structure of the Navy Publications and Printing Office (NPPSO), nor do they operate the extensive field operations and facilities as does NPPSO.

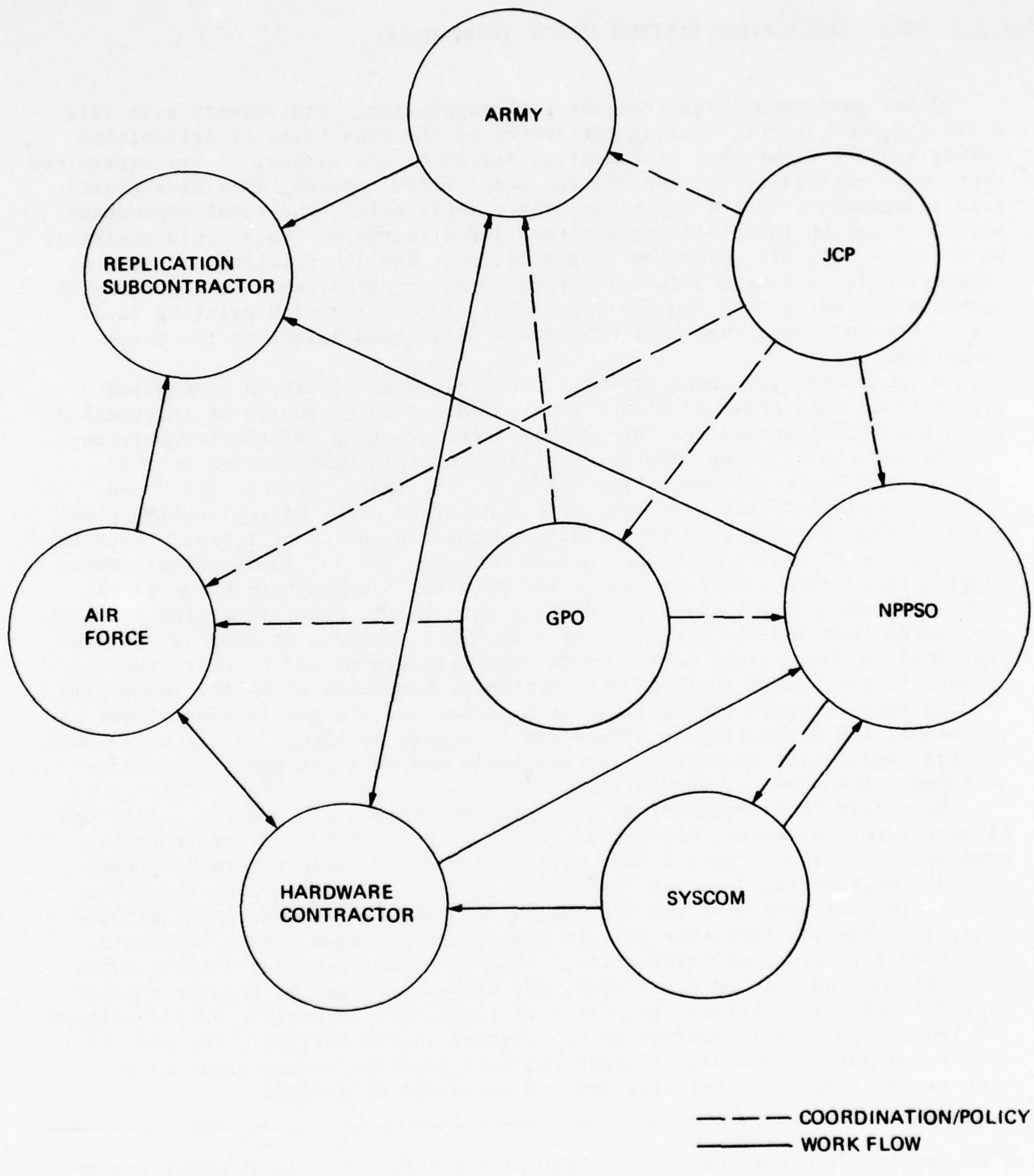

Figure 3-38. Interfaces Between the Navy and Other Branches Involving Replication Matters. Treatment is similar except that the Army and Air Force now have little involvement in microform operations.

3.5.1.2 OTHER REPLICATION SYSTEMS IN USE (Continued)

Other government organizations with replication requirements also fall under the JCP control. During the survey of the Department of Agriculture (USDA) and the Department of Commerce, Bureau of the Census, it was determined that their capability for replication was limited. Hence, they have considerable dependency on GPO to perform their replication, and total dependency on GPO to set up their subcontracts per JCP directives. This would generally be the case with all government organization. The JCP printing and binding regulations[1], listing plants authorized to do printing, show many government agencies including USDA and the Department of Commerce with printing facilities. However, more than half of the 300 authorized belong to the three armed services.

Because the government organizations rely extensively on commercial replication, this area was also investigated. A major source of information was a document prepared for the Graphic Arts Marketing Information Service (GAMIS) and the Printing Industries of America (PIA) association by the Graphic Arts Technical Foundation (GATF)[2]. The terms "graphic arts" and "graphic communications" are generally synonomous with the replication processes of the printing industry. This information and other research covered a wide range of commercial replication including labels, forms, boxes, newspapers, year books - even oranges. The printing industry prints on cloth, film, cardboard, metal, paper, and other materials. Paper is by far the most replicated form and the principal area of NTIPP concern. Technology is conventional in the private sector, with more evidence of advancement, due perhaps to the profit motive. The newspapers have been among the leaders in finding ways to speed the replication process, and all are looking at new techniques and automation to offset labor rate escalation. All in all, commercial replication operations are available and well-equipped to continue to support the needs of the services.

Microform "Micropublishing" is a growing commercial industry as the use of microforms increases, especially in the private sector in reference or archival type data. Parts lists, personnel records, supply catalogs, bank records, engineering drawings and dozens of similar applications have been found. The services also use microforms for many of the same applications. Also, like the services, the private sector has not made a mass switch to microform for technical information. Although libraries have put thousands of books and journals on microforms, the users still prefer to make a paper copy for use. Nonetheless, the field is large, and technology well-developed and improving. Should microforms proliferate in the services, the private sector can furnish adequate support for both replication and creation of masters, and provide other services and equipment as needed.

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[1] "Government Printing and Binding Regulations - No. 23," Joint Committee on Printing - Congress of the United States, October 1974.

[2] Graphic Arts Technical Foundation," The Impact of Technology on Graphic Communications 1976-1981," <u>GAMIS/PIA</u>, April 1976.

Within NTIPP, the relationship of the private sector to the Navy is a supportive one. Most of the micropublishing and paper media replication required for technical publications is subcontracted. Distribution is also often handled by the subcontractor, although controlled through the SYSCOM/NPPSO operation. There is little, if any, direct Navy relationship with the other services' replication organizations, except through the common control of the JCP.

No strong operational interrelationships exist among the Navy, the other services, and the private sector, except in regard to subcontracting. There is a strong functional relationship, however, since all are accomplishing their missions using long-established and basically traditional methods and techniques. Sophistication is most likely to occur more rapidly in the private sector, due to its competitive nature, and because the Services are restrained by the approval/funding/procurement cycle and the JCP emphasis on subcontracting.

TABLE 3-XXX. COMMERCIAL PUBLISHING IMPACT ON NTIPP REPLICATION REQUIREMENTS AND TECHNOLOGY

- Presently handled related to technical manual replication:
  - Books
  - Newspaper
  - Periodicals
  - Forms
  - Financial and Legal
  - In-Plant
- Present items with little or no impact on technical manual replication:
  - Cartons
  - Fruit
  - Metal
  - Flexible Packaging
  - Label
  - Corrugated Board

3.5.1.3 STATUS OF PRESENT MICROFORM TECHNOLOGY

The current microform world has benefitted from the attention paid to standards and controls. Competition has spurred technical improvements to processes and hardware, although basic technological approaches are the same today as ten years ago.

Modern microfilming includes the use of retrieved reduced-size images in active business, technical, and commercial use. It has long since evolved from a solely archival method of storing data in reduced space to its present dynamic use in everyday data applications. The space-saving factor still remains, but speed of retrieval, ease of referencing, and other handling and use characteristics are additional factors adding to its wide acceptance. The thrust of technological advances in microforms is directed toward improvement of production, storage, handling, and use.

Microform development to date has benefitted from industrial cooperation and coordination through the professional societies and government agencies. The predominant influence has been the National Micrographics Association and its work in establishing and coordinating standards and controls. As a result, film types, sizes, data formats, and reduction ratios are now orderly and defined. Although the Navy has two microform types for technical manuals, they are each standard forms. As previously stated, the microforms are basically 35mm used primarily for aperture cards, 16mm used for roll film and jacket microfiche, and 105mm x 148mm (often referred to as 105mm) for one-piece microfiche. Microfiche seems to be the form currently being selected for more of the new applications, although there appears to be no redirection of the extensive use of 35mm aperture cards for engineering drawings, or for forms other than fiche in other applications. The investment is usually sizeable by the time a microform system is installed, and it takes time to amortize the cost.

Microform images are created through a camera process or by computer-output-microform (COM) equipment which could be considered a cathode ray tube camera. Other than COM, two basic types of cameras are used - rotary and planetary. The latter can be subdivided into conventional planetary cameras and step-and-repeat cameras. The main difference between the two types is that in a planetary camera, the original and the film are both stationary, while in a rotary camera both are moving. In the planetary camera structured for step-and-repeat (microfiche filming) the film is moved after each exposure in predetermined steps. The choice of which camera to use depends on the work to be processed. Rotary cameras are much faster, can handle originals of any length, can simultaneously expose two films at different reduction ratios, and cost less than planetary cameras. However, film quality is better from a planetary camera since lighting and exposure of each frame can be individually controlled as it is shot and nothing is moving. One point of concern on any type of camera is that halftones (photographs constructed with dot patterns or continuous tone photos) do not retain contrast when enlarged to original size. There is a serious degradation of quality. Since a "black and white" type film is commonly used for microfilm, the use of continuous

tone artwork is also limited in microforms. Continuous tone films as well as color are available - but very seldom used. Most military and commercial specifications on preparation of material to be microfilmed stipulate that line drawings should be used in place of photographs.

Film processors which chemically develop the film and fix the image permanently are a part of the total microform technology. This is usually an off-line process, since one processor can accommodate the output of several cameras. Processors are also automated to a degree since with many devices a roll of film (or stack of sheets) can be fed into one and the developed, fixed, and dried film comes out the other end. It is a well-established technology.

Microform replication uses the previously described materials and processes - silver halide, vesicular, and diazo. Replicating devices usually are roll-to-roll or cut sheet-to-cut sheet. The latter category includes the card-to-card replicators for 35mm film in aperture cards. Roll-to-roll duplicators provide contact between the master film and the copy film by means of endless belts or by tension of the two films as they pass over the exposing roller. Cut sheet replicators usually use vacuum contact for exposure. Both types often include both exposure and processing in the same unit. Technological improvements to these devices have been in the area of speed and making the processing automatic.

Readers and reader-printers are familiar devices to those handling technical information - the principle is film projection for readers and for reader-printers, the added technology for copy equipment. The newer printers most commonly employ a heat-developed dry silver photographic process for printing a viewed image. Automation of search and retrieval mechanisms and systems, flexibility for using the single device for several forms (fiche, roll, cartridge), different enlargement ratios, and viewer size reduction are the areas being refined. The latter, viewer size reduction, is of particular concern to the Navy. Completion of the NAVSUP R&D effort DoD Personalized Portable Micromedia Display System should find users, since there is a need for a lightweight portable viewer.

Storage methods for microforms are varied and, for military use, often customized to the environment. The developments have been largely toward storage devices to accommodate a wider range of users and some mechanization to ease use. No significant impact on other aspects of microform technology is apparent in this area.

Computer-output-microform (COM) systems and equipment were discussed as an output for the content capture function. The COM devices for that purpose were considered to have graphic capability, and therefore to be the higher-cost units. However, COM has wide application outside of the publications field. There are a great number of low-cost alphanumeric COM units providing high-speed microform output for ADP applications. Technology has advanced to where the laser is being used in more and more COM devices as the output imaging vehicle. COM is an integral part of the microform field, and will be a dominant factor in the continual use and development of the microform medium.

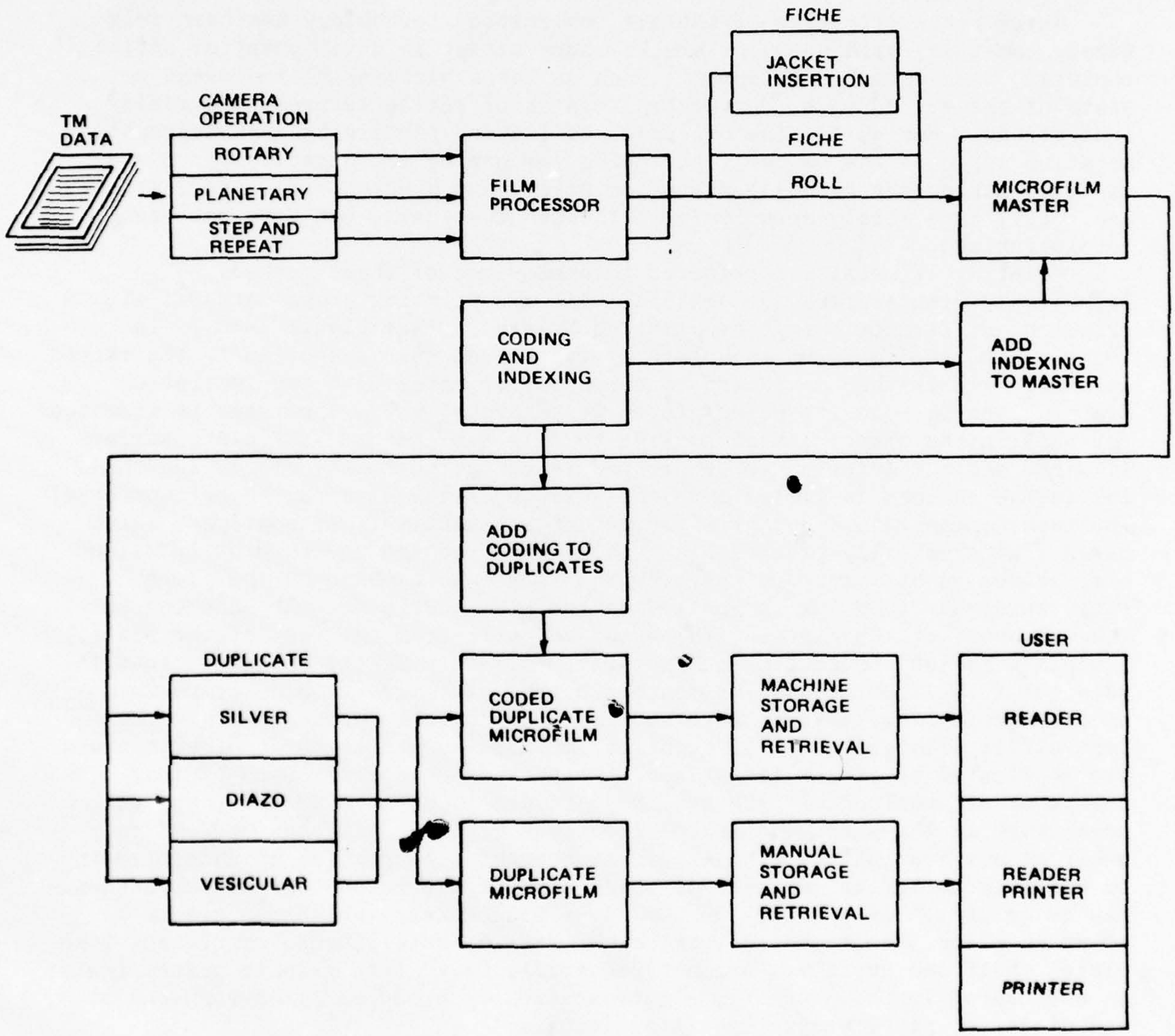

Figure 3-39. Typical Processing Steps in Final Processing of Microforms. Technology is well-developed and is continuing to be refined.

3.5.1.4 STATUS OF PRESENT PRINT IMAGE TECHNOLOGY

Changes in conventional printing technology have been slow to develop, while the technology applied to "copy" machines has produced some dramatic results.

Until recently, state-of-the-art replication technology has been relatively constant, with no major breakthrough except in development of office copiers. Some recent developments such as laser platemaking represent a state-of-the-art advance, and others such as offset letterpress are really innovations. Basically, the processes of imaging (obtaining a photographic negative image of the master), stripping (preparing the negative for platemaking), making the printing plate, printing, and binding (collating, drilling, etc.) have merely been improved through the years, but have not been revolutionized.

Printing is usually considered to employ one of three methods - lithography, letterpress, or gravure. All are printing press methods, with a principal difference being the printing "plate." (See Figure 3-40.) In letterpress, the image on the plate is raised and ink is applied to the raised surface which is then contacted to the paper or material being imprinted. Gravure uses an opposite principle to letterpress, where the image is indented (etched) in the plate, ink is applied to fill the indents, the plate surface is wiped and the material to be printed is contacted to the plate, and the ink in the indents is lifted onto the surface of the material being imprinted. The most common method for printing technical manuals is lithography, which has a flat chemically-treated plate that, when exposed and chemically washed off, leaves an oily residue wherever the image was exposed on the plate. First water and then ink is applied to the plate, with the ink adhering to the oily part of the plate. (The water keeps it from the rest of the plate.) The plate is then contacted to a separate roller (blanket) which contacts the material to be imprinted. The contact of the plate to the blanket to the material being imprinted is referred to as an "offset" process - thus the term offset lithography. All technical manuals when printed as paper media are replicated by offset lithography. Letterpress is still used by many newspaper and periodical printers, and gravure is often used for long-run color work in the packaging and publications fields. Although obvious to publications specialists, the above was presented to provide an understanding of basic technological methods to which some of the technological improvements can be related. In addition to the laser platemakers, which can create a printing plate from magnetic tape, other developments include continuous tone plates (halftone negatives are not required), "dry" lithographic plates (water is not needed in the process), electrostatically produced lithographic plates, and direct-to-plate projection from microfilm.

Automation as applied to total printing process is primarily in the binding function. Systems are used that automatically collate, fold, trim, drill (if needed), and bind (staple, "perfect," etc.). The more sophisticated systems are found where high volume and high throughput speed is needed, such as newspapers and periodicals. These applications also use multihead presses to print many pages in the same pass.

Even as improvements in techniques and processes develop, they are slow to be adopted. This is due primarily to the high capital investment involved in being in the printing business, and particularly in the type of printing most common to technical manuals. Technical manuals are always short-run (a few hundred copies) and often large documents (several thousand pages) which limits their being processed in the same manner as a newspaper. The cost of installing and operating the highly sophisticated large scale systems (as used in newspaper or periodical printing) is prohibitive for technical manual printing.

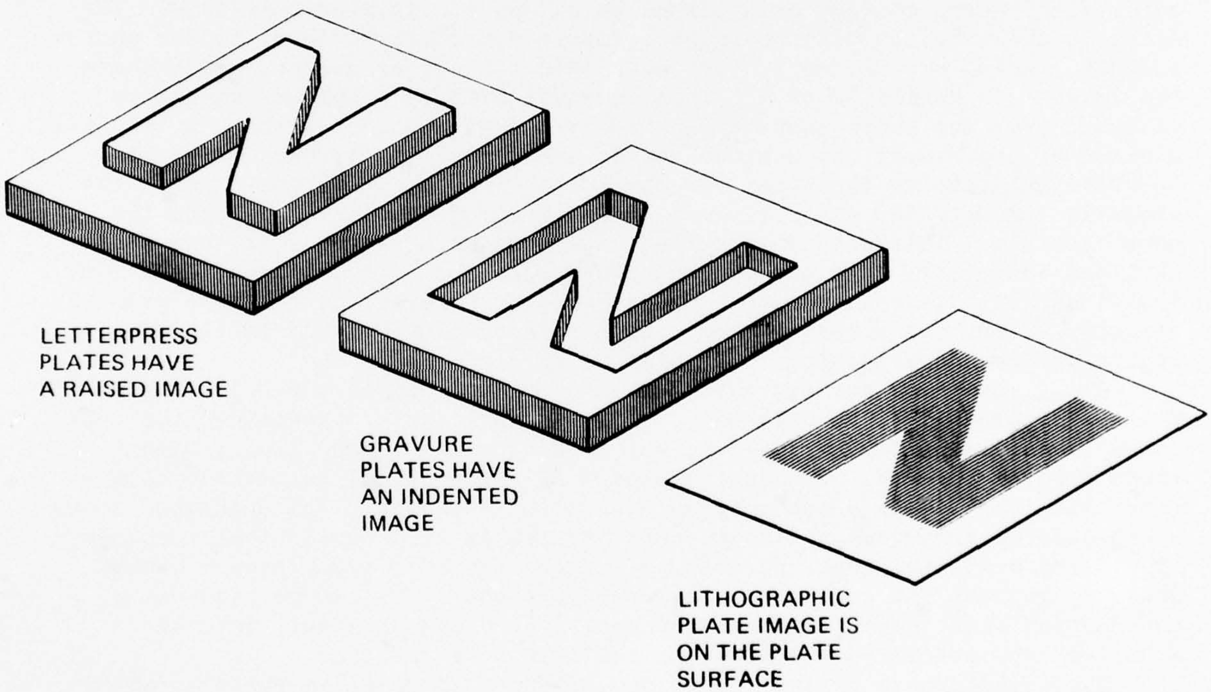

Figure 3-40. Essential Differences Which Identify the Printing Process by the Form of Printing Plate. Apart from plate-oriented distinctions, the three processes are functionally similar.

3.5.1.4 STATUS OF PRESENT PRINT IMAGE TECHNOLOGY (Continued)

The copy machine field has shown more dramatic development. From the early thermographic systems, where a page and the copy material were fed slowly one by one through the machine, there are new copy machines that produce color and copy machines that are input with digital mag tape.

The thermographic copy process, which uses the heat principle to develop special sensitized paper contacted to an original, has given way to the electrostatic copy process - also referred to as an electrophotographic process. (See Figure 3-41.) There are two methods to produce electrostatic prints, direct and indirect. In the basic indirect method, a photoconductor is used which is exposed (using a light source) with the image to be copied after first being charged by a corona which has a high static voltage. The areas of the original with no image reflects a high light level to the photoconductor which discharges it leaving a latent image of charged areas where the image is. Particles of a carbon compound with an opposite charge are cascaded over the photoconductor and adhere to the charged areas. By placing a piece of paper over the photoconductor and applying a strong charge of opposite polarity to the paper the particles will adhere to the paper. The image is fixed to the paper by heating and melting the particles into the paper surface. This method is called indirect, because the final print is obtained indirectly from the charged photoconductor. If the paper used for the final print is coated with a photoconductor material it could be printed directly - thus the direct method. Both methods are employed in electrostatic process copy machines presently being used.

Among the major current advances in copy machines is the color copier that can reproduce color originals. It is a three-color process so the copy loses considerable color fidelity, but is adequate for many applications where color is needed. The copier separates the original into three colors - red, blue, and yellow - and applies each color separately (as described above using colored granules). Also recently available is a copier that receives input from a digital tape and outputs an electrostatic image copy. Other advances include the copier that can reduce the original image size and copy the changed size image, automated mechanisms to feed originals into the machines, and automated collaters on the output of machines.

The significance of the technology advances to copy equipment to NTIPP relates a probable future direction in replication - the on-demand or quick-reaction capability. In this concept, the technical information would be delivered in digital form, to be replicated at or near the point the data would be used. One concern is the development of a system that could accommodate graphics as well as text. As graphics processing is developed in the digital capture, conversion and data delivery systems, attention must be given to on-demand replication systems that interface to the digital data flow.

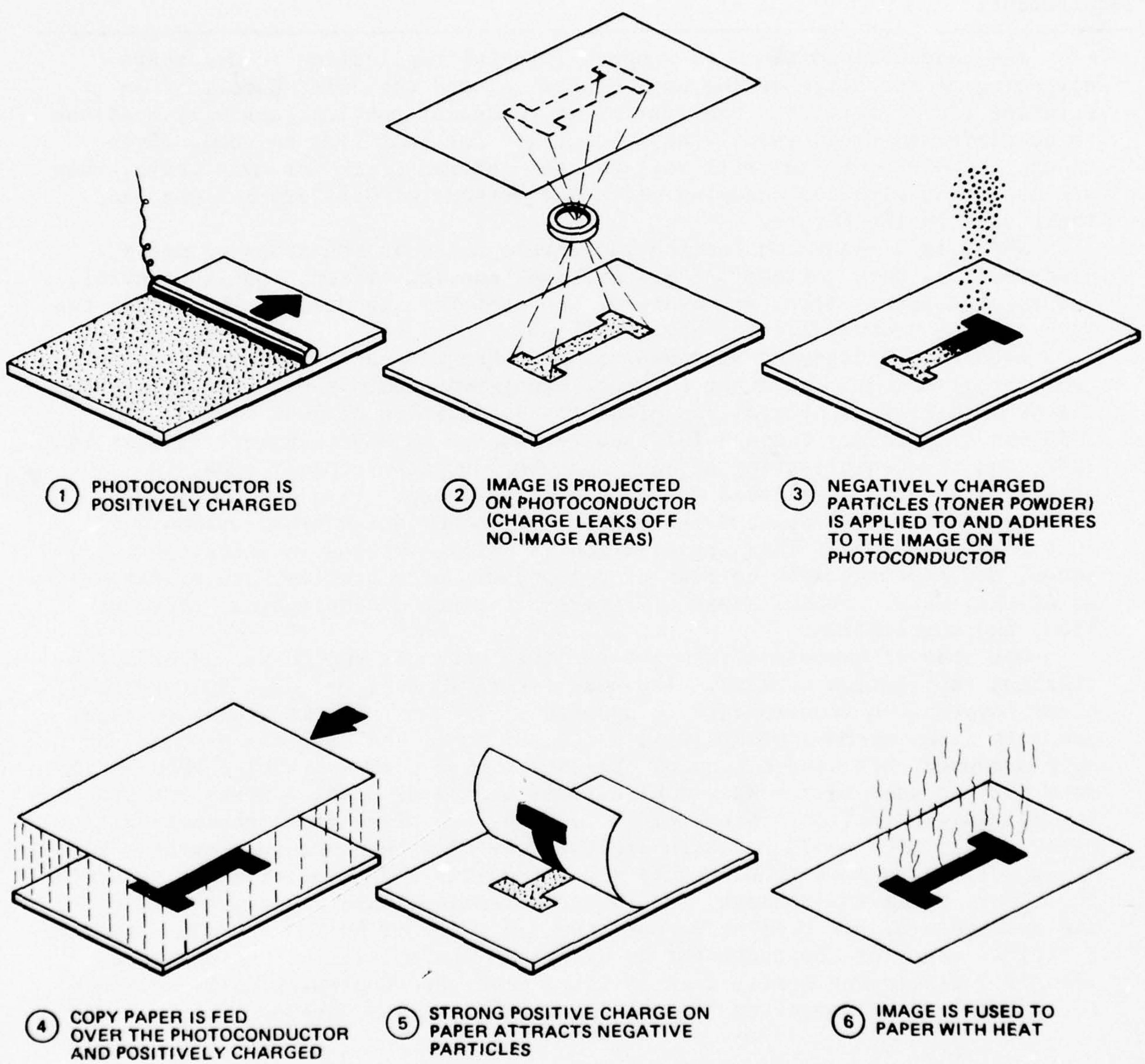

Figure 3-41. The Electrostatic Copy Process. This is the most commonly used for office copiers, and poses potential advantages in on-demand replication.

3.5.2.1 PROPOSED NAVY REPLICATION SYSTEMS

The role of NPPSO may change as new methods and techniques are applied to the capture and delivery of MOTD. On-demand replication approach is an emerging requirement.

The Navy will continue to support internal replication requirements advancing as the state of the art, economics, and the Joint Committee on Printing (JCP) dictates. Replication of technical publications will continue to be performed predominantly by subcontract for some time to come. Even though the NPPSO presses will roll and the cameras click for many years, they are concerned with the changing media and methods of delivery and use, and their role in the future.

NPPSO is already considering the developments in the areas of media, distribution, data collection, preparation, and conversion, quality control, and related areas. They are aware of the need for standardization within the Navy and the technical information problems.

A Central Management Navy Reprographic Program covering inventory control, program cost, and other internal management factors has been initiated. The NPPSO microform program has plans for acquisition of 8000 viewers and 2055 viewer printers through 1977, conversion of 65,000 technical manuals in 1977, and the consolidation of Navy computer-output-microform (COM) in specified geographical areas (7 planned at present). In addition, a NPPS-directed Automated Graphic Science Program, (AGSP) RDT&E organization has just been announced. This organization is still evolving in definition, scope, and approach with no plan of action, resource profile, and milestones as of this date. Stated areas of interest include micrographics, reproduction, and duplication.

One area of expressed interest for the future is the on-demand or quick-reaction replication systems. The need for rapid user response to the technical information requirements is apparent. If available in nearby storage areas in film, or more probably in a digital form, the user can produce, or have produced, his needed copy of the data. Even for the routine request for data that is sent to the Navy Publications and Forms Center (NPFC) for processing, quick-reaction systems could be used. In place of warehouses full of paper books, NPFC could maintain digital data or a random access machine full of microfiche masters to reproduce the one or two copy replenishment requests. In a paper media environment, original replication would be distributed to the defined users as presently done, and, in place of bulk, NPFC would receive a digital tape for replenishment as described above. Variations of these ideas for developing media, such as video disc, are technologically feasible. Development of equipment to support the concept will be needed.

On-going improvement of existing Navy facilities will be necessary to maintain cost effectiveness. New technological developments in processing used in printing and the entire micropublishing field (film-to-film, film-to-paper, paper-to-film) are pertinent to the future for Navy replication functions. NPPSO activities should be directed toward these targets along with the on-site on-demand type replication methods.

Changes being projected for the Navy capture, conversion, delivery and use of technical information will take several years to develop. Conventions of today will remain, including the nearly total dependence on subcontractors to replicate technical manuals per the Joint Committee on Publishing (JCP) direction. This raises a final point that the proposed Navy replication systems may be impacted by the role of the JCP. The effect of that impact is unknown and needs to be assessed.

TABLE 3-XXXI. EFFECT ON STORAGE AND DISTRIBUTION THROUGH EVOLUTION OF ON-DEMAND REPLICATION SYSTEMS

Requirement	Present System	Limited On-Demand System	Total On-Demand System
Bulk Storage	Yes	No	No
Initial Distribution	Yes	Yes	No*
Replenishment	Yes	No	No
Change Distribution	Yes	Yes	No

*Data available from data bank on-demand.

3.5.2.2 PROPOSED ARMY AND AIR FORCE AND OTHER REPLICATION SYSTEMS

The Army and the Air Force reliance on subcontractors for technical manual replication, along with budget constraints, limits participation in advances being made. Competition and the profit motive drives the private sector to more cost-effective means.

Future development of the Army and Air Force replication functions parallels the Navy inasmuch as their replication, including technical publications printing, is subcontracted per Joint Committee on Printing (JCP) directive, and their approval/funding cycles for new equipment can be equally as difficult and protracted. It can be assumed, but not supported in the research, that the Army and Air Force will be more actively investigating new presentation techniques and media for technical information than they are now.

The program on human readable/machine readable (HRMR) film being performed by the Air Force has not, to date, been applied to technical manuals, but likely will be considered. However, since the USAF has dropped the Technical Order Microfilm System (TOMS) program it can be deduced that they will not depart from paper TOs at least for the next five years. It follows that the Air Force replication functions will also remain status quo for that period. It appears that they will remain relatively static until new presentation techniques and media are developed that require a reassessment of replication needs.

The Army has no media plans that could be discovered other than those related to the Improved Technical Documentation and Training (ITDT) program. The media impact in that program is in the potential use of audio/video devices to support the field training aspects of ITDT. Technical Manuals remain as paper and limited microform media, and replication requirements call for conventional processing methods. The TM microform program in the Army, which is now a dual microform/paper system, shows no apparent signs of growth and expansion. The Army, like the Air Force, will have minimal advancement in replication technology over the next five years, and longer if the developing presentation techniques and media are not to be part of the Army long-range development plans, which appears to be the present case.

Among the other government agencies surveyed with departures from their present method of operating and media use, is the National Science Foundation (NSF) with their involvement in the "Electronic Journal." Agencies such as the Departments of Agriculture and Commerce will continue in the foreseeable future as they have in the past. NSF, since the "Electronic Journal" concept is a rough parallel of some of the potential Navy concepts, will also parallel the Navy replication issues as presented in this section to some degree.

The future development of those commercially engaged in printing of paper media will have an influence on NTIPP since nearly all technical manual printing is subcontracted commercially. This influence is principally economic because, since the manuals must be printed, the printing should be obtained at the least cost. Commercial printing is a highly competitive industry, in most areas, so maintaining a position of low cost and reasonable profit makes commercial printers alert to technological advances to improve that position. Most of the improvements previously mentioned and discussed in the following topic are the wave of the future in commercial replication. The new

magnetic-tape-driven platemaking methods using lasers and electrostatics would interface the developing digital output content capture functions of NTIPP. Sophistication of the bindery operations and other areas where manual methods could be automated are other improvements to look for. In time there will be impacts from dry lithography and continuous tone (screenless) lithography. As previously reported, the newspaper and periodical printers will lead in the implementation of the new paper replication methods, with the smaller commercial printer adopting those things that can be cost effective for him. Even should the use of paper disappear as a primary media in technical manuals it will be around for other uses for many years. It has taken 300 years to learn how to use it, and it is not likely to go away quickly.

Microform media conversion and replication are considered an interim media for DoD organizational level maintenance technical publications. Acceptance has been less than spectacular - as evidenced by the status of Air Force and Army programs. Navy programs - the long-standing MIARS in NAVAIR which has received better acceptance than most, and the just starting NAVSEA microfiche program - will still be around for the next several years at least. They must be supported by micropublishing capabilities, which will be largely commercial, although NPPSO has provided a complete in-house capability at Pt. Hueneme. The proliferation of commercial micropublishing operations highlights at least two factors. First, there is confidence that for many applications micropublishing will continue to flourish (there is no evidence to the contrary), and second, there will be adequate commercial support of microform conversion and replication needs for many years.

The future of replication in the Army and Air Force will be directed by a combination of media evolution (toward a digital-based or other optic medium) and by the continued JCP influence on replication issues. However, it should be considered that there may be a medium for delivery of technical information that would not fall under JCP influence.

The private sector future appears to be a copy of its past. There will be continual improvement and development to meet the needs of its wide variety of replication processes and products. Although most technological change has not been, nor does it appear to be (in the future), very spectacular, it will be constant. As a matter of fact, for many years the cost of paper replication did not increase (and in some years it decreased) before the inflationary spiral of the past few years and then the major element of cost increase was the cost of paper. So, the projection for the private sector as it relates to the support of the services, in both paper replication and micrographics, is that it will be as it has been - a reliable and efficient source to support replication needs.

In comparison of the services, the Navy with the NPPSO has a more extensive central replication arm, while the Army and the Air Force are not set up to provide the same extensive capability in their centrally controlled structure. Other government agencies generally have less replication capability than any of the services, and no strong central control mechanisms. They rely on support from GPO to a great extent and on the subcontractor. The private sector has excellent capability in most aspects of replication, but a comparison to the services is not valid since their structure and operation is purely commercial and controlled almost totally by economic factors.

3.5.2.3 TECHNOLOGY: PRINT IMAGE AND NONPRINT IMAGE TECHNIQUES

The most significant improvements in print image technology appear to be in office copier equipment. The significant developments in nonprint image technology, as it pertains to NTIPP, are in areas other than micrographics.

A wide range of improvements is in the offing in the replication field, both in print image and nonprint image technology. Many of these are relevant to the technology used to support the conversion, replication, and delivery of technical information.

In the print-image area, continual process improvement efforts exist to maintain or improve the cost effectiveness level demanded by competition. Those that pertain to this study are presented below:

In imagery systems, the optical system (camera) will give way to the scanning systems. Scanning is the technology whereby a page is scanned and the areas of image and no image converted to a digital representation for further processing. Both text and graphics can be scanned as images. There is already considerable attention on scanning for color separation, and dot generation for halftones is perfected for scanning systems. With these devices, an original can be scanned into the system and the output subsystem could create a photolithographic negative or a printing plate (laser or electrostatic). Microforms, video discs, and holograms are also technically imaging systems, but nonprint image type. Output-to-video display devices also fall into this category.

For the preprint operation, or plate-making, there are the previously mentioned developments in electrostatic plates which can be made on office copy machines, and the laser plate-making process which is similar to making plates on photocomposing equipment. The laser device can be driven from a digital input generated by an automated publications system, or one created by an image scanning device. Plates from photocomposers are directly exposed as output, in place of the normal repro copy or page-size negatives. Computer output microform (COM) equipment is also used in dual media systems (paper/microform) to create the master microform which can also be used to prepare a printing plate by optical projection. Dry plate lithography is a developing process (the normal lithographic process uses water), but development has slowed due mostly to economic factors. Cost of conversion is high, and no order of magnitude improvement in speed of processing or reduction in handling time can be promised at present. Developments are underway (and more are expected) in the plate materials to be used in new approaches, in the use of automated plate processors (exposed plates may need development and/or fixing), and in using the computer to control the total process.

Screenless (no dot pattern) lithography is in the projected technology to be considered. Its development is expected to be slow, due to its expected high cost and limited application. Its major impact on NTIPP is in the area of using photographs in microform, since the dot-pattern halftones are not usable. However, if development of the method is slow, microforms (at least for the Navy's technical manuals) may be phasing out by the time the method is available.

In the press operation technology, there are a few developments forecast in the areas of smaller web-fed presses, drying systems, and in-line binding, but the major item is the continual development of ink-jet printing which is discussed in more detail later in this topic. The web-fed press, where a roll of paper (in place of sheets of paper) is fed into the printing press, has been predominant in printing operations, with the need to turn out large quantities of printed material quickly, such as newspapers. Technical manuals are printed on sheet-fed presses. However, effort is now being directed at getting smaller, lower-cost web-fed equipment developed for other applications. The advantages being sought in the development of the smaller web-fed press are less energy and less manpower to run and represent a smaller capital investment.

In regard to ink drying systems, which currently use gas heat, an energy-saving effort by the printing industry is to develop alternatives. Processes being investigated are ultraviolet light drying methods and "overcoating." Overcoating is the process of applying a quick hardening material over the ink as soon as the sheet has been imprinted. Both show promise. In-line bindery methods being considered involve the technique of attaching to the printing press, on-line, the various processes of folding, trimming, collating, binding, stocking, and packaging. Much attention has and will continue to be placed on improving this technique, since it reduces manpower needs.

Bindery technology development is aimed at improving the speed of flow from printed page to finished product. The on-line system described above, or variations of it, is expected to develop. The bindery is also a place where computer control can be applied as the automated on-line devices are implemented. This area is receiving attention particularly in newspapers and other high-volume, high-speed operations.

Expected advancement in the copier field will be predominantly in automated feed mechanisms and in on-line binding. Collating equipment has already been married to the office copier output. Computer-controlled digital input electrostatic device development is expected to continue.

Magnetography is another technology being mentioned for copiers or other applications now performed using electrostatic methods. Magnetography is similar to "electrostatography," using an electromagnetic principle instead of the electrostatic. Also, for consideration in areas where technical information would be presented on a video display device, photoresponse materials can be used to make a hard copy (paper base) from the video image. This technology is basically developed, but does not appear to have been applied to possible devices or systems relative to NTIPP potential needs.

Further, the electrostatic copier technology and the ink-jet printer are prime candidates for the on-demand quick-reaction capability being discussed for potential NTIPP and other user data applications. The Navy should look toward an active role in the research and development of these technology areas.

3.5.2.3 TECHNOLOGY: PRINT IMAGE AND NONPRINT IMAGE TECHNIQUES (Continued)

Ink-jet printing is a method that shows promise for the future. Ink-jet printing is not new, having been introduced several years ago, but it is unfamiliar to many. Ink-jet printing deposits drops of ink at high speeds on a fast-moving web (roll) of relatively absorbent paper. (See Figure 3-42.) The principles employed are first, the application of a fixed-frequency vibration to a stream of ink which breaks it into uniform size droplets, and second, the droplets are moved about, to form the image on the paper, by computer-controlled electrostatic charging. Ink-jet printing employs a single movable head jet stream (although more than one head can be employed) on a fixed head multiple jet (hundreds of jets), with both techniques applying the jet(s) of ink to a movable web of paper. The movable head method can form 250 characters per second per head, while the fixed head matrix of jets can reach speeds of 45,000 lines per minute. The systems are computer-controlled and digitally fed. Quality has been a problem that is now being solved in recent systems, and it should get better. Also, the systems do not presently have graphic capability, but it is technologically feasible and development effort is expected.

In the nonprint image area, there is considerable activity in processes, but not in replication technology. Perhaps the most attention is to microforms, the media next to paper in frequency of use for technical information. The National Micrographics Association (NMA) has recently established a special subcommittee of the Long Range Task Planning Task Force to perform a technological assessment of the image-processing industry to identify future industrial trends and opportunities. Results of this effort will not be available for some time, but should be monitored by NTIPP. In the analysis of micropublishing conducted for this study effort, there were several areas identified where development is presently concentrated or considered for the future. Generally, these are not directly replication-oriented. Computer-Output-Microform (COM) is a technology, although previously reported, that bears additional mention since it shows signs of being a primary conversion method in micrographics. As more and more information is processed and output digitally, the COM device becomes the logical output device. COM development is principally in the laser area, in place of the CRT, and it appears it will continue in that technology for the foreseeable future.

Communication of information to support micropublishing is another area of development. Other than the methods discussed previously, which were digital transmission, is the transmission of microform images. The most likely method for this is microfacsimile, which is the basic facsimile process refined to transmit a microimage with very high resolution. This technology is receiving attention by major micrographics equipment manufacturers, and should be considered as a viable research area. Developments in facsimile will involve the scan-to-microfilm concept. This is basic technology that can use existing methods refined for microimages. The existing digital scanning methods tied to a COM device provide a rudimentary system. This is looked on as a "scanning" imaging system, as opposed to an optical (camera) imaging system similar to that discussed for print-image technology. This area of nonoptical methods and techniques appears to be

the way the technology is heading. The only other developments determined to be receiving attention are the previously mentioned automation of processing and replication equipment and systems. As long as the Navy uses microforms for technical information, technology development should be monitored and R&D efforts supported.

Other nonprint image methods of concern to NTIPP are the video disc and the holograms. The recently published NTIPP video disc technology assessment[1] provides an in-depth look at the technology and provides some technological projections. Video discs will be available in the time-frame of concern to the current NTIPP effort and represent a candidate media. There has been no previous NTIPP investigation of hologram technology. A hologram, in the pure sense, is a three-dimensional representation of an object created on a photographic plate, using the principal of splitting light from a laser into two beams. One beam (reference) is directed onto the hologram plate, and the second is directed through mirrors to illuminate the object. The light reflected from the object mixes with pure light from the reference beam to form an interference pattern on the plate. This pattern is called a hologram. Digital information can also be created on the film in the same "three-dimensional" manner which makes it almost impossible to destroy information with scratches on the film. Further, both digital data and visual images can be put on the same film. This is the approach being taken by the Air Force (RADC, Rome, N.Y., HRMR Project), and it appears to have possible application to technical information delivery and use requirements. The advantage of this system is that in areas that have microfiche, it can be an easy transition medium, using the same storage systems and providing both human-readable and machine-readable (HRMR) in the interim between the microform system and the replacement digital system. It is an interesting concept, and one that appears could be less costly than video disc. It should be considered along with video disc as a potential delivery and use medium of the 1980s. Figures 3-43 and 3-44 show how the digital portions of the HRMR holograms are created and converted for use.

Replication of both video disc and holograms will be developed as the media develops. Technology for each is basic and conventional. The video discs, depending on how created, can be recreated by pressing as with phonographic records, or copied using a photographic process. Holograms can be copied in the same manner as microforms are now reproduced. The most common process would be diazo, although silver halide and vesicular can be used.

All of the above represent a discussion of replication and related data on print-image and nonprint image technology. Some of it will apply to NTIPP as it evolves - much may not. Technology development in regard to the replication issue will not impact NTIPP, except as it pertains to the presentation methods and media and to the organizational entities that will implement the concepts, policies and procedures of NTIPP.

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[1] Poe Engineering Services, "Photographic Video Disc Technology Assessment," David Taylor Naval Ship Research and Development Center, October 1976

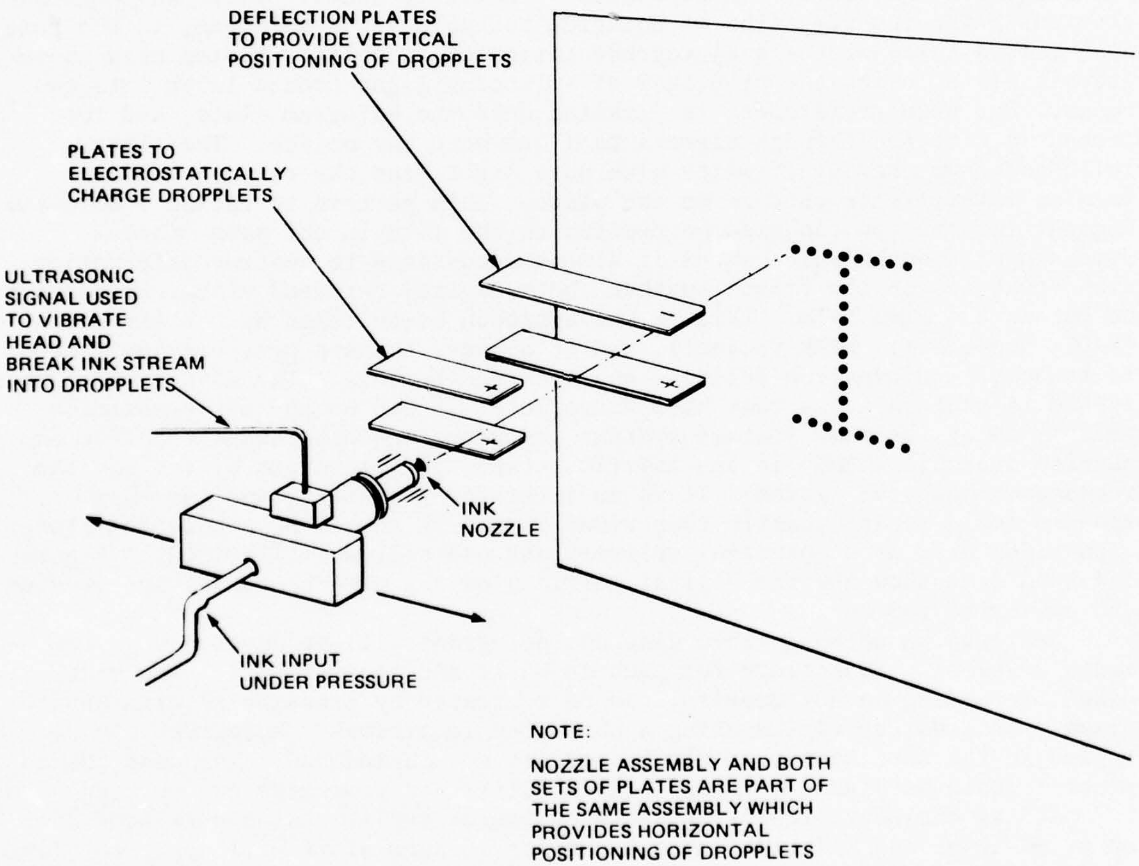


Figure 3-42. Movable Head Ink-Jet Printing Technology. This method of printing can be computer-controlled, and can convert digital data to alphanumerics.

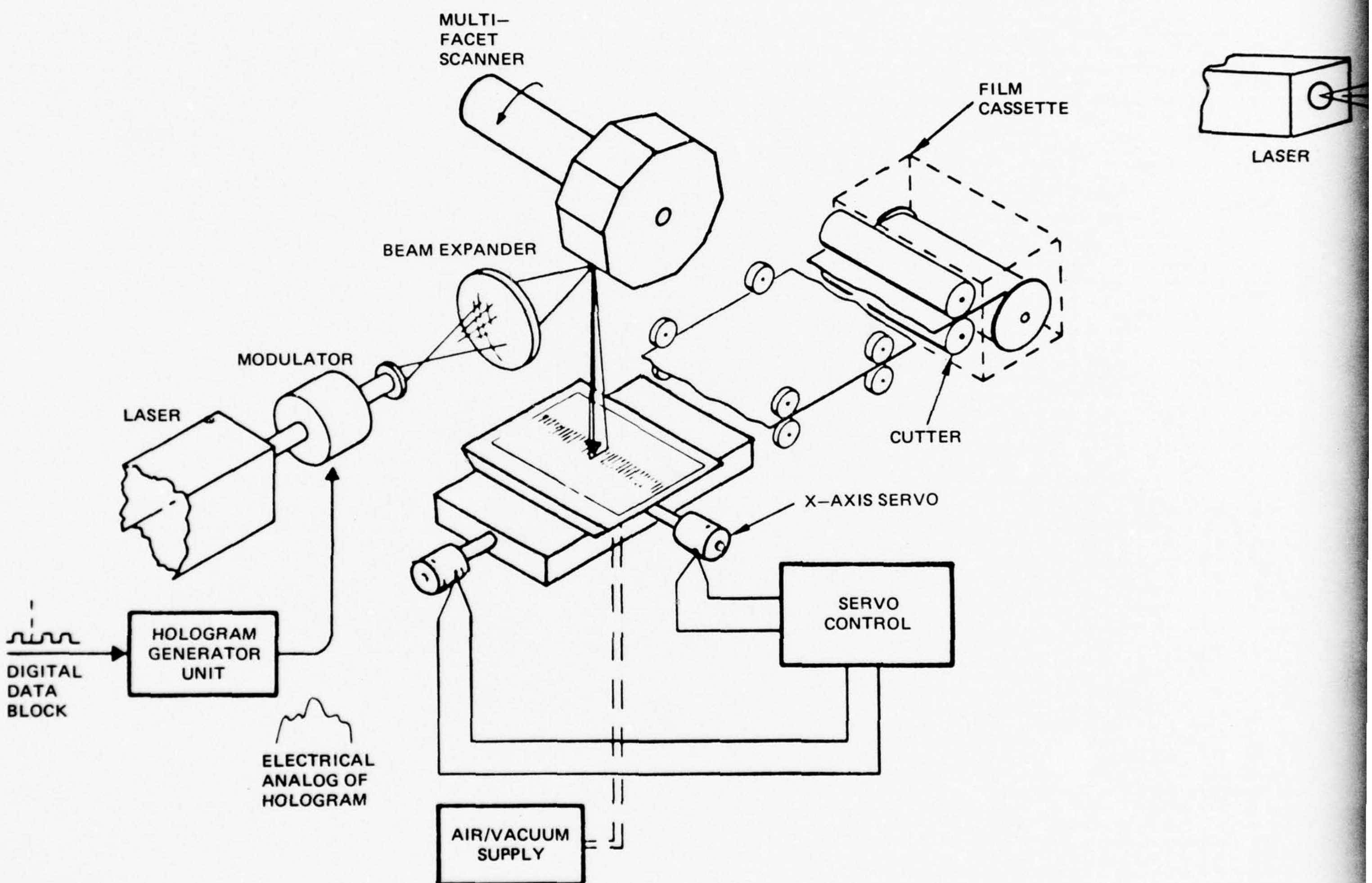


Figure 3-43. Human-Readable, Machine-Readable (HRMR) Digital Data Recorder. The system simulates the holographic principal in recording a digital "image." Human readable image is recorded by conventional photographic means.

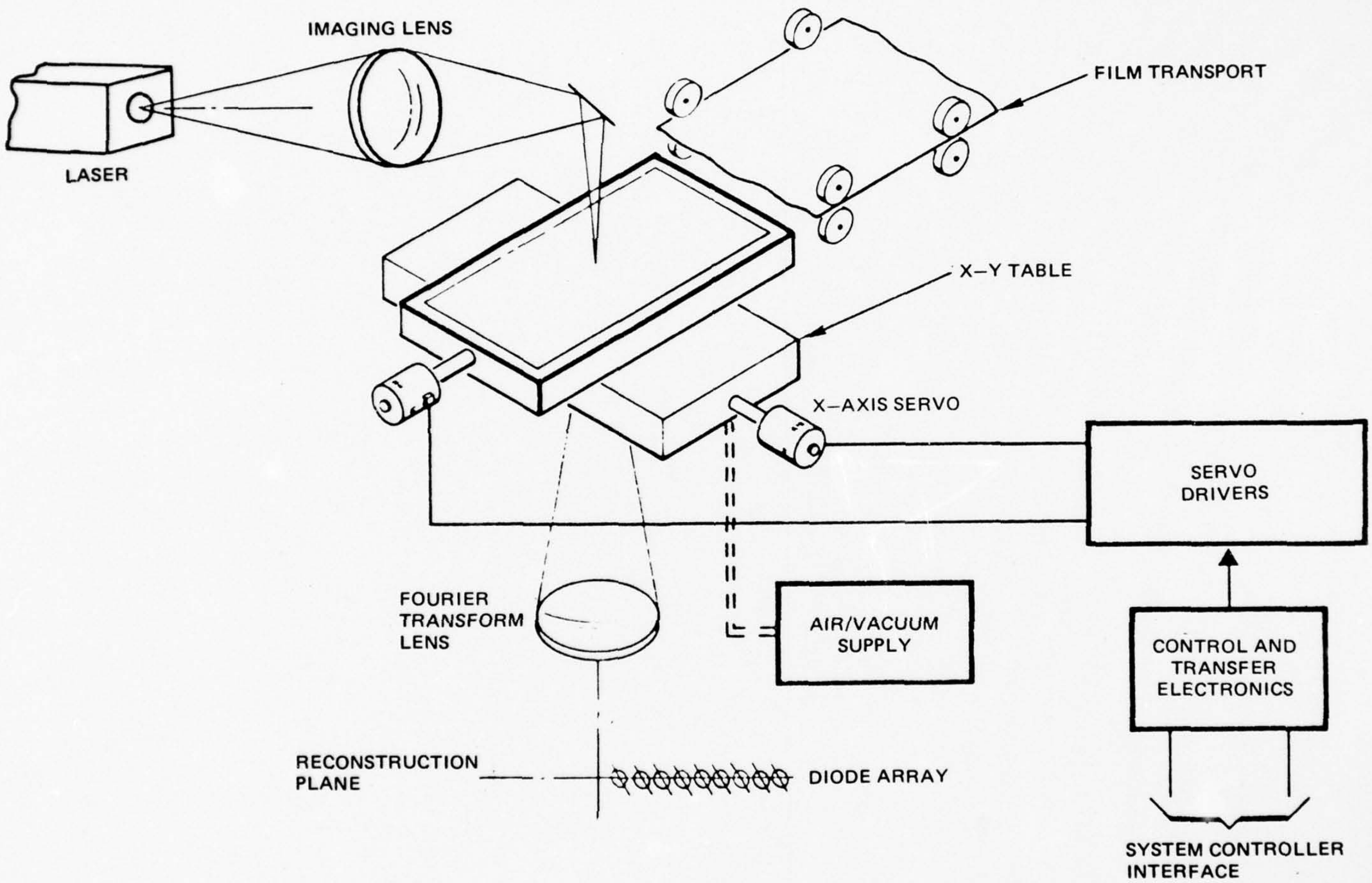


Figure 3-44. HRMR Digital Data Readout Module. The digital "image" is reconstituted as digital bits which can be read into digital systems.

SUBSECTION 3.6
RESEARCH ISSUE 6: DISTRIBUTION

3.6.1 DEFINITION AND OBJECTIVE OF THE DISTRIBUTION FUNCTION

Distribution activity in today's MOTD environment begins early in the acquisition process, and continues for the entire life-cycle of the data. Distribution encompasses such varying functions as configuration control, physical deployment, storage, retrieval, and management reporting.

Distribution, as a functional element of the Navy's data acquisition process, is most commonly thought of as the last event to occur in the process of providing maintenance and operating technical data (MOTD) to users in the fleet. Such a definition normally brings to mind visions of warehouses, fork-lifts, pallets of boxes, and people hurrying about, filling orders. While such a view has, to a degree, basis in fact, the distribution process in today's MOTD environment comprises more than just the operation of various warehouse activities. In reality, distribution is a management subfunction of the entire MOTD life-cycle process. It normally begins with the assignment of TM ID numbers during preliminary development, and may not end until the equipment has been declared obsolete and all pertinent MOTD has been deposited in a Federal Records Center. The distribution activities occurring between these two diverse points in time are the subject of this research issue. (See Figure 3-45.)

For the purposes of this investigation, and in the interest of maintaining some reference in time to the MOTD life-cycle, the functions of distribution have been divided into three major areas: (1) initial distribution, (2) resupply, and (3) archive. As these areas are very broad in nature, they facilitate investigation without unduly restricting it. At the same time, they provide an elemental framework of reference through which the investigation may proceed. A brief description of each illustrates this point.

Initial Distribution - Initial distribution refers to those activities which result in the deployment of MOTD for the first time. Whether it is new data, or changes and updates to existing data, makes little difference in the fundamental processes involved. During this period, distribution requirements are determined, configuration control is instituted in the form of TM ID number assignment, a point of central storage and supply is designated, and actual deployment occurs. Of particular significance during this period is the initiation of data management techniques which essentially provide administrative control of an item for the remainder of its life-cycle.

Resupply - Activities occurring in response to user demands for resupply of MOTD are typified by an MOTD user's submission of a requisition for resupply of some specific data. The supply point then processes the user's request, retrieves the data from storage, and packages and delivers it. Of particular concern to this investigation are the methods and means employed to report stock status and replenish it when on-hand balances fall below acceptable levels.

Archive - Archive is a two-fold subject. First, it applies to the operation and utilization of an historical library of deployed MOTD by the SYSCOMs. Second, it refers to the method of storage, control, retrieval, management, and utilization of repro-master copies used for replenishment of supply stocks.

This investigation has been directed primarily at the distribution procedures employed by the NAVAIR, NAVSEA, and NAVELEX system commands. Although other activities within the Navy (NAVSUP in particular) participate to some degree in the distribution of technical documentation, it is believed the activities of the three major system commands typify the majority of those functions. In addition, for further reference, the Army and Air Force systems were investigated to determine how distribution of technical data is administered in those environments. The facing illustration shows a typical flow of Navy distribution activity with major participating activities noted.

The primary influence on proposed distribution systems will result from change in media. As the future media requirements of published MOTD are shifted, at least in part, from today's hard copy to microform or digital forms, new methods of distribution must be implemented. The use of digital media and on-site, on-demand replication may also alter the role of distribution by allowing MOTD to be deployed directly from the content capture function to the user site.

The primary objective of this investigation is to evaluate and compare the various systems of MOTD distribution currently employed and being proposed for the future. In addition, an attempt will be made to determine what steps, if any, are being taken to cope with the impact of projected changes in media.

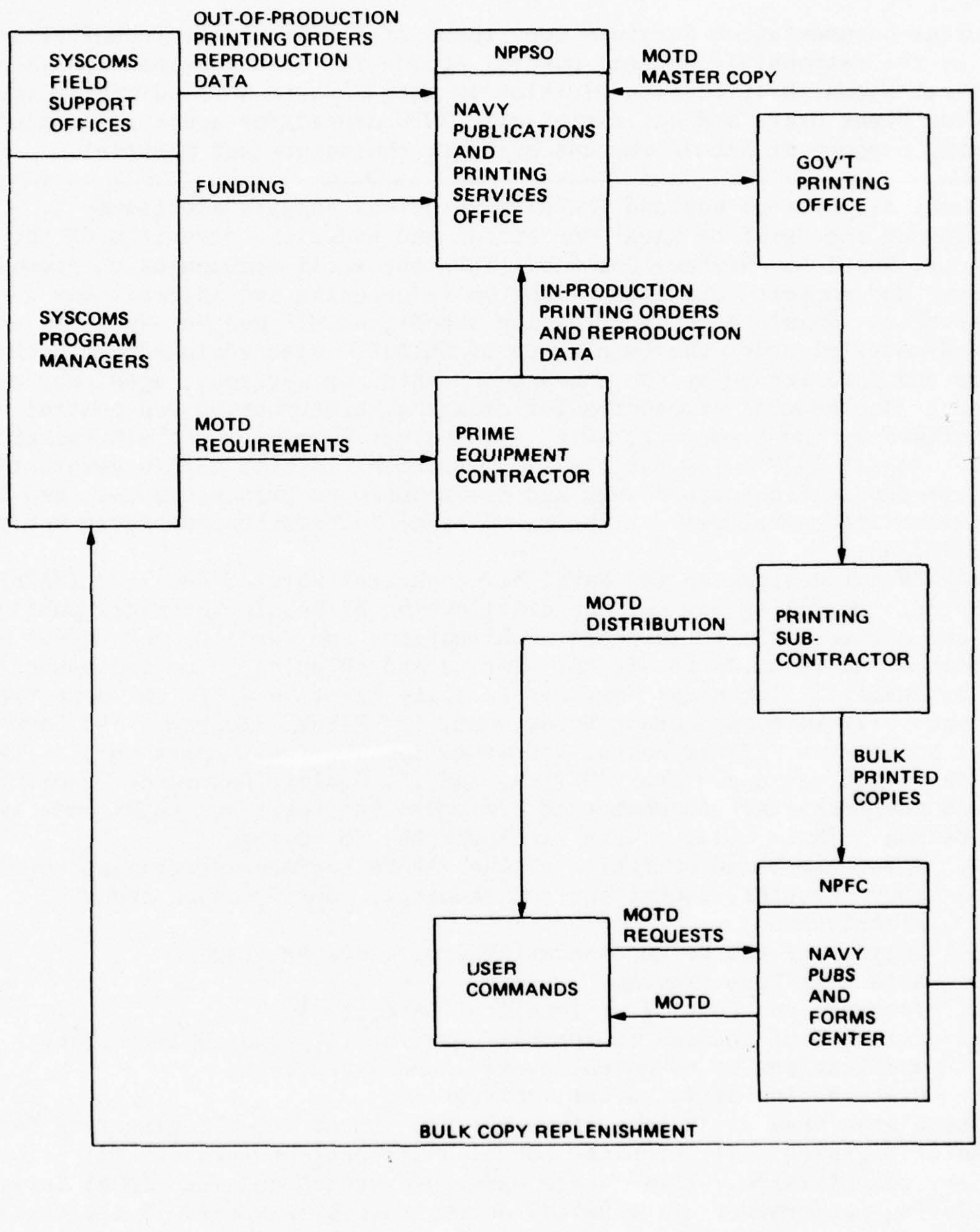


Figure 3-45. Typical Flow of Activity in a Navy Distribution System. The distribution system in the Navy environment is in effect a management subfunction for administrative control of MOTD throughout its life-cycle.

3.6.2 CURRENT NAVAIR MOTD DISTRIBUTION SYSTEM

The Technical Documentation Services Department of the Naval Air Technical Services Facility is the responsible central control agency for distribution of NAVAIR MOTD. The Technical Manual Distribution Division in that department is directly involved in providing Fleet Users and Activities with MOTD needed for operation, maintenance and training support of NAVAIR weapons systems, equipments and material.

Naval Air Systems Command (NAVAIR) technical manuals are issued by authority of the Chief of Naval Operations and under the direction of the Commander, Naval Air Systems Command. This technical documentation provides the fleet and support activities with the information and instructions needed for operation, maintenance and training support of all weapons systems, equipment and material under the cognizance of NAVAIR. Also included are technical manuals and data issued by and exchanged with other services, agencies, and commands. The general procedures for ordering, distribution and control have been defined by the Commander, Naval Air Systems Command in NAVAIR Instruction 5605.4A, August 1976. The basic policy statement is that NAVAIR aeronautic technical publications are issued and distributed as printed copies, and in 16 mm microfilm cartridges for the Maintenance Information Automated Retrieval System (MIARS).

NAVAIR has designated the Naval Air Technical Service Facility (NATSF) as the central control agency for the distribution of NAVAIR technical publications and documentation. The Naval Publications and Forms Center (NPFC) is responsible for actually receiving, storing and shipping technical manuals.

The Naval Air Technical Services Facility has five different departments. These are: (1) Data Management Department, (2) Plans, Programs, and Comptroller Department, (3) Technical Documentation Services Department, (4) Naval Aviation Periodical and History Office, and (5) Quality Assurance Department. Of these the Technical Documentation Services Department has cognizance over distribution. Their total charter includes the following:

a. Maintenance and operation of the NAVAIR Engineering Drawing Repository (receipt, identification, control, reproduction, and distribution)
b. Support of the Defense Security Assistance Program
c. Work Unit Code Program
d. Issuance and Control of Technical Directives
e. Issuance of indices to identify availability and configuration applications of technical manuals and directives
f. Distribution of Technical Publications

There are three divisions within the department: (1) Engineering Data Management Division, (2) Technical Manual Distribution Division, (3) Technical Data Services Division. These three have information and functional interfaces during performance of technical documentation services. But technical data distribution is the responsibility of the Technical Manual Distribution Division. There are two branches in the division, Distribution and Reproduction Control. The Distribution Control Branch has three sections: (1) Requirements Control Section, (2) Customer Information and Allowance

Section, (3) Defense Security Assistance Program Section. The Reproduction Control Branch has a Publishing Support Section and the Technical Library and Archives Section.

In general there are three types of distribution for NAVAIR technical publications:

- Initial Outfitting
- Automatic Distribution
- One-Time Requests

Initial outfitting is for new activities (squadrons, air group, AMID, etc.) or existing activities with a change in mission, required operational capability, aircraft or equipment. Initial outfitting is based upon the basic allowance for the activity. The Technical Manual Distribution Division has several types of automated initial outfitting lists: General Aeronautic Technical Publications, Specific Aeronautic Technical Publications, and Subsequent Outfitting. After any Initial Outfitting List (IOL) is issued, the requesting activity is placed on the automatic distribution list. Future issues, changes, corrections, etc. will be automatically distributed in the same quantities as indicated on the initial allowance.

Automatic distribution is the system in which publications are issued and distributed in accordance with the predetermined requirements of the using activities. The operating concept is to provide automatically, changes, revisions, and new publications to the proper users in the proper quantity. The fleet users and activities are best able to determine their continuing requirements for technical publications. Therefore, NAVAIR 00-25DRT-1, Naval Aeronautic Publications Automatic Distribution Requirements Tables (DRT) are completed by organizations with continuing requirements for technical publications on a specific aircraft, missile, drone and/or engine. NAVAIR 00-25DRT-1 contains the instructions and forms for establishing these automatic distribution requirements. The Technical Manual Distribution Division at NATSF maintains files of the technical publication requirements for each activity. Files are revised whenever a change is reported on the DRT. As the DRT is only used to place an activity on the mailing list for automatic distribution, it cannot be used as an ordering blank for existing publications. Assistance in obtaining automatic distribution is provided by local NAESU Technical Publications Representatives or by NATSF.

One-time requests for technical publications are requisitioned from the Naval Publications and Forms Center (NPFC) in accordance with procedures outlined in NAVSUP Publication 437, Military Standard Requisitioning and Issue Procedures (MILSTRIP). The Automatic Digital Network (AUTODIN) facilities or the Automatic Voice Network (AUTOVON) are both used for requests. NAVSUP 2002 identifies the publications and directives required by the activities. The one-time request will not result in an activity being placed on the NAVAIR Automatic Distribution List. Therefore, subsequent changes and revisions to the publication requested will have to be ordered separately. If the activity submitted a change using the Automatic Distribution Requirement Tables (DRT), only then would that publication be included on the automatic distribution list. Special requests for publication and directives can be requisitioned from NPFC via the AUTOVON when the item(s) are listed in NAVSUP 2002. The

3.6.2 CURRENT NAVAIR MOTD DISTRIBUTION SYSTEM (Continued)

technical publications not listed in NAVSUP 2002 may be requested from the Technical Manual Distribution Division at NATSF. They will process the request and forward to NPFC for supply action.

Distribution of technical manuals includes the requisition and supply functions as part of the total evolution. The distribution network with the agencies involved and the request and supply action transmittal path is shown in Figure 3-46. While the information flows and transportation media are not specifically shown, they are considered as part of the action pathways. The most important loop in the network encompasses the fleet users/activities, Naval Air Technical Service Facility and the Naval Publications and Forms Center. Initial outfitting, automatic distribution and special requests normally travel through this loop. The fleet activity initiates the technical publication request and forwards it to NATSF. Prescribed procedures are followed at NATSF, including information exchange with NPFC, and the requisition is sent to them for subsequent action. NPFC follows the prescribed supply procedures for their organization and sends the publications to the requesting activity. There is one variation which applies to the one-time request for technical publications. As shown in the network, the request and supply action is a direct path between the activity and the Aviation Supply Office Distribution Point or the NPFC. NAVSUP instructions would apply to the one-time request whereas NAVAIR instructions would pertain to the other request/supply actions. However, when an item is not in stock (NIS) at NPFC, then the loop expands to include other agencies such as placing a demand on NPPSO for another printing of the item. In such an instance, NPPSO contacts the Government Printing Office or printing contractors for a reprint job. A request, from NPPSO, for publication mailing labels is set to NATSF. These are prepared by NATSF, sent to NPFC, and then forwarded to the printer. Upon completion of printing, the printer mails the requested number of publications to the addressee. Remaining copies are sent to NPFC for stock replenishment.

The contractor can be a requestor or an originator of technical publications. The request loop is through the NPRO, NPSSO, and NPFC, who forwards the publication. Appropriate ONMINST and OPNAVINST procedures would be followed. When the contractor originates a technical publication that will require reproduction and distribution to fleet activities, the loop expands to include NATSF, NPFC, and printing contractors.

The general public may also purchase unclassified technical publications. The request is processed through NPPSO, includes NATSF for research, identification and location of the publication. Delivery would be made by NPFC. In some instances reproduction and delivery could be assigned to GPO.

Organizational responsibility for the TM archives is within the Reproduction Control Branch of the Technical Manual Distribution Division. There are two sections, Publishing Support Section and Technical Library and Archives Section, within the branch. Compiling and maintaining the archives is the job of approximately six employees in Technical Library and Archives Section. The section consists of a classified library, unclassified library, and the MIARS/Archives group. The archives are primarily historical, containing a copy of the publication or MIARS cartridge of the technical manuals for the past

10 years. The production negative needed for publication reprinting, etc., is usually stored elsewhere in a contractor or cognizant field activity. The filmed manuals in reels, MIARS cartridges, etc., are retained for 10 years. During the eleventh year these items are transferred to the records center for another 10 years. After that period they are sent to the National Archives. NATSF does not retain control of items accepted by the National Archives.

It is apparent that NATSF is the key to the NAVAIR publications distribution network. They are involved in practically all of the distribution evolutions. However, their primary concern is the fleet users and activities, and their overall objective is to satisfy the publication requirements for each. NATSF has numerous lines of communications with these activities and assists in solving their MOTD problems.

3.6.2 CURRENT NAVAIR MOTD DISTRIBUTION SYSTEM (Continued)

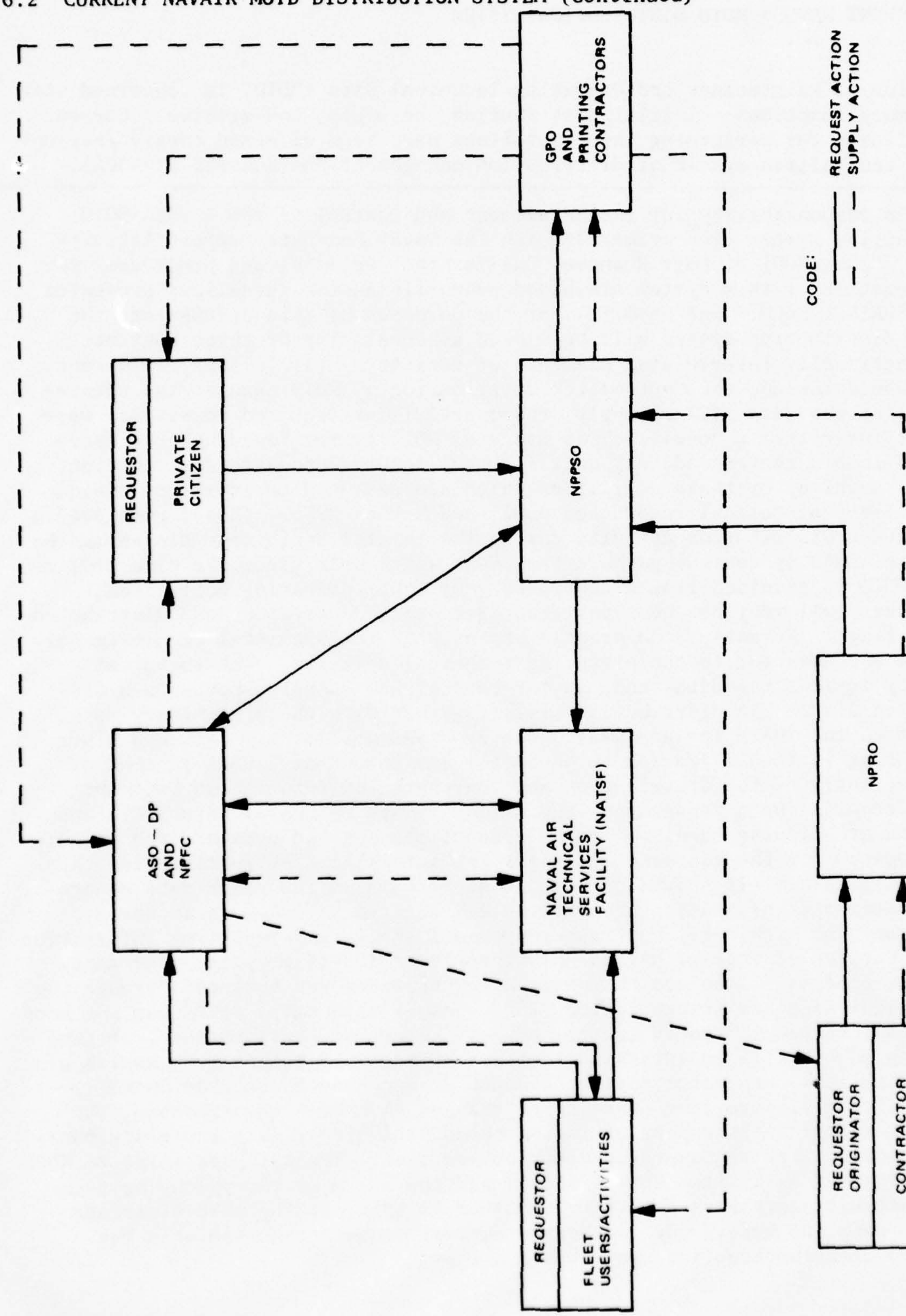


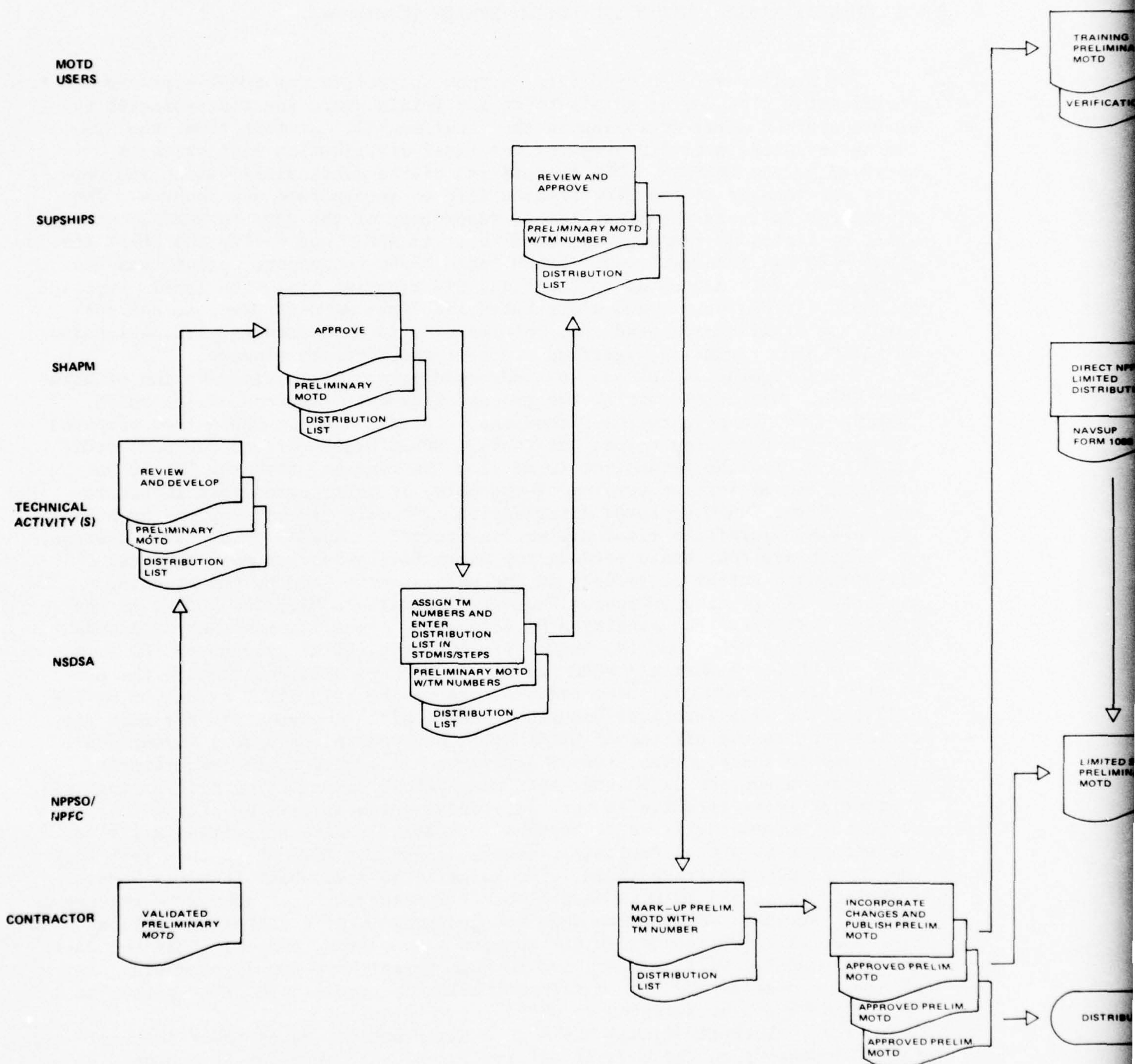
Figure 3-46. Flow of Activity in the NAVAIR Distribution System. The organization of this system allows "automatic" initial deployment of changes, updates and new MOTD, as well as "one-time" resupply of user data replenishment requirements.

3.6.3 CURRENT NAVSEA MOTD DISTRIBUTION SYSTEM

Distribution of Maintenance and Operating Technical Data (MOTD) is concerned with three primary functions: initial distribution, resupply, and archive. Current NAVSEA policies for performing these functions have been directed toward development of a centralized system of distribution management and control at NSDSA.

The responsibility for the management and control of the NAVSEA MOTD distribution system lies primarily with the Naval Sea Data Support Activity (NSDSA, Code 5700) at Port Hueneme, California. Policies and procedures for the operation of this system are based primarily on the guidelines presented in NAVSEAINST 5600.7 and 5600.8. For the purposes of this discussion, the NAVSEA distribution system will be viewed as consisting of three distinct, but functionally interrelated elements of activity: (1) initial deployment, which would include the "automatic" distribution of MOTD changes and updates, as well as new data; (2) resupply, those activities required to satisfy user demands for either a "one-time" issuance of MOTD or for "loading" the user request into a central address data file for future automatic distribution; and (3) archive, or those activities which are designed to store, maintain, and retrieve historical records of published NAVSEA MOTD. (See figure 3-47.)

NAVSEA distribution activity during the initial deployment stages can be best explained by reviewing those functions which occur from the time preliminary MOTD is received from a contractor, or other preparing activities, until the final copy has been verified, accepted, replicated, and distributed to the fleet. Normally, the process begins with the submittal of preliminary MOTD by a contractor to the procuring technical activity. The technical activity reviews the data, and, in the case of new manuals, prepares a distribution list. The distribution list, together with the preliminary data, is sent to the SHAPM for approval. The approved preliminary data and distribution list is then forwarded to NSDSA for assignment of NAVSEA TM control numbers, entry of the distribution and configuration information into the Ships Technical Data Management Information System (STEDMIS) data file, and creation of shipping labels. In the case of changes and updates, the file is interrogated for the addresses of users on "automatic distribution" for this particular data. (It should be noted that STEDMIS is the prime data management system for information about technical data in NAVSEA. It is not a repository for such data, but rather provides status and reporting information on any particular item of NAVSEA MOTD throughout its life cycle. The capabilities of this system are currently being expanded and enhanced through the development of a new system called STEPS. As of this date, STEPS has not been fully implemented.) The TM control numbers, approved distribution list, and shipping labels will be furnished to the contractor, together with copies of the preliminary data which must be changed in accordance with the SHAPM/technical activity review. Once these changes have been incorporated, the contractor replicates copies of the approved preliminary data and distributes in accordance with the approved distribution list. Those copies going to NPFC are designated as limited access stock, and the SHAPM or the procuring technical activity initiates a NAVSUP Form 1088 to NPFC, noting that clearance must be obtained before any interested activity, other than those on the approved distribution list, may obtain a copy.


MOTD USERS
SUPSHIPS
SHAPM
TECHNICAL ACTIVITY (S)
NSDSA
NPPSO/ NPFC
CONTRACTOR
VALIDATED PRELIMINARY MOTD
REVIEW AND DEVELOP
PRELIMINARY MOTD
DISTRIBUTION LIST
APPROVE
PRELIMINARY MOTD
DISTRIBUTION LIST
ASSIGN TM NUMBERS AND ENTER DISTRIBUTION LIST IN STDMIS/STEPS
PRELIMINARY MOTD W/TM NUMBERS
DISTRIBUTION LIST
REVIEW AND APPROVE
PRELIMINARY MOTD W/TM NUMBER
DISTRIBUTION LIST
MARK-UP PRELIM. MOTD WITH TM NUMBER
DISTRIBUTION LIST
INCORPORATE CHANGES AND PUBLISH PRELIM. MOTD
APPROVED PRELIM. MOTD
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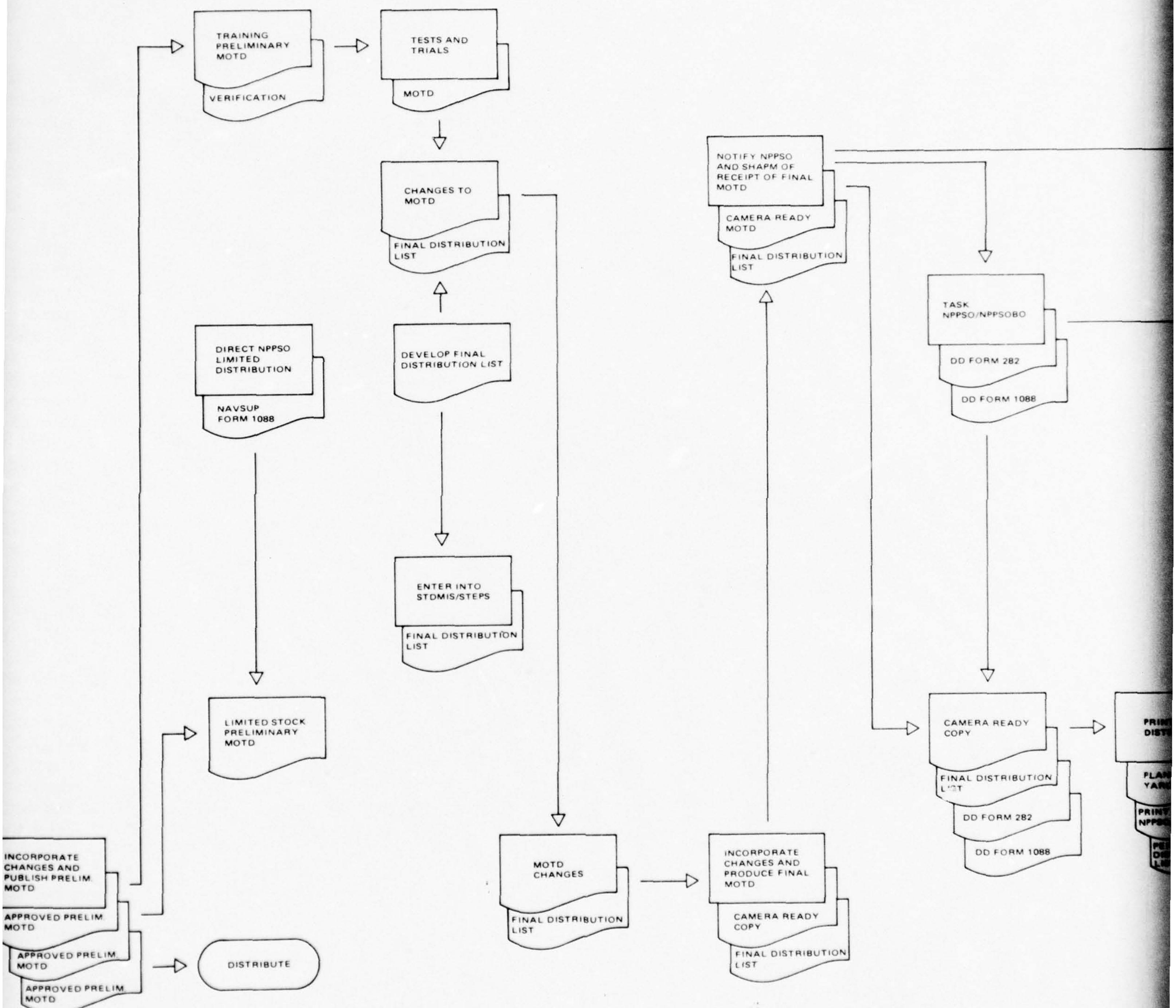
NAVSEA INITIAL DEPLOYMENT



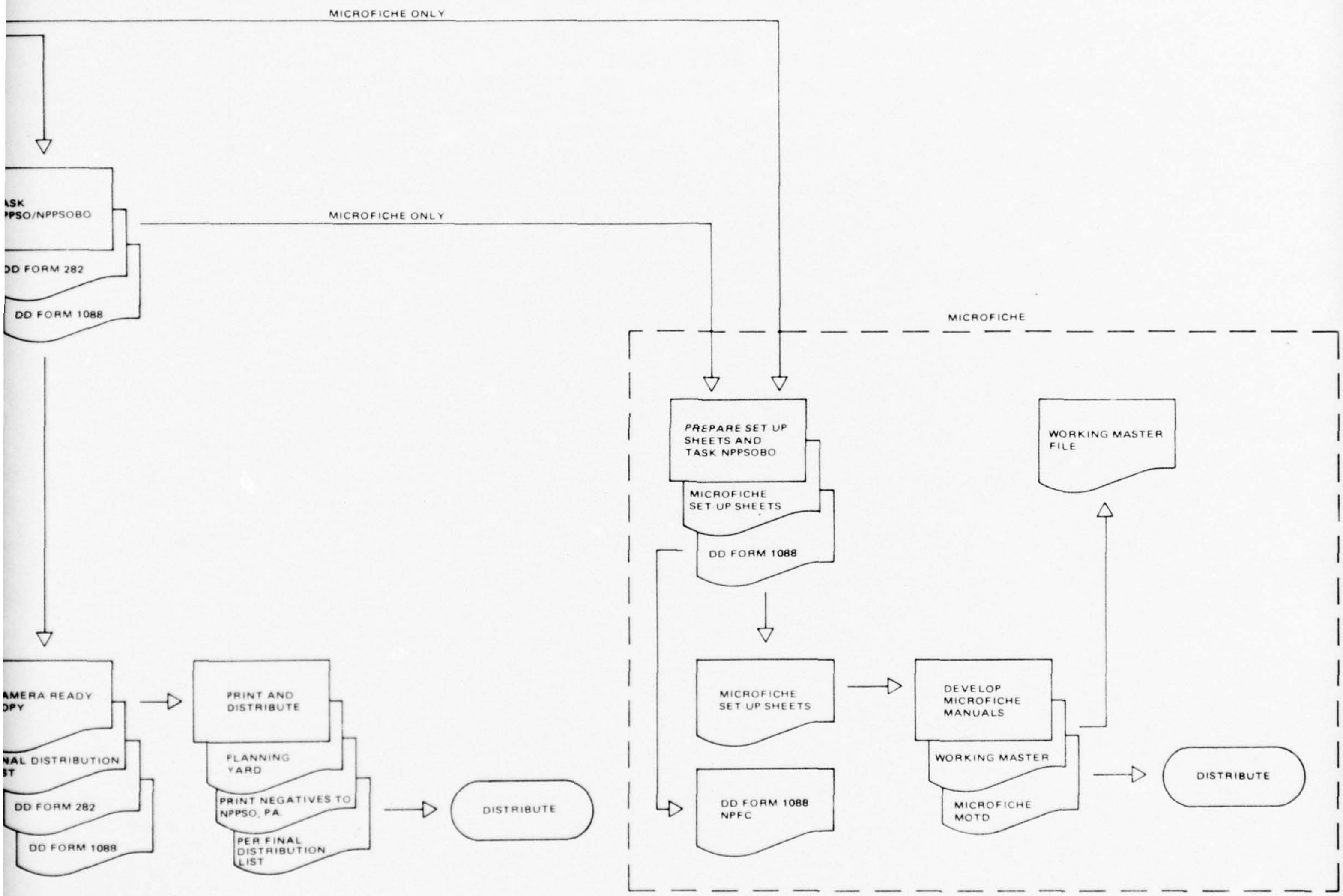


Figure 3-47. Flow of Activity in the NAVSEA Initial Distribution System. Management control and coordination of distribution activity is the responsibility of NSDSA.

3.6.3 CURRENT NAVSEA MOTD DISTRIBUTION SYSTEM (Continued)

The preliminary deployed data is then subject to the SHAPM-approved verification plan during ship's tests and trials where any discrepancies or errors are noted for inclusion in the final manual. At this time, the procuring technical activity prepares the final distribution list which is approved by the SHAPM. NSDSA is notified of the final distribution and performs maintenance to the STEDMIS data file to incorporate any changes. The contractor delivers the final camera-ready copy of the data to SUPSHIP who will, by letter of transmittal, furnish it to NPPSO and notify the SHAPM the final MOTD has been reviewed. SHAPM tasks NPPSO to inspect, print, and distribute the data according to the final distribution list with labels supplied by NSDSA. NPPSO prints and distributes the final MOTD as directed and forwards the final camera-ready copy of the data to the planning yard designated by the SHAPM. Printing negatives are sent the NPFC for storage.

The foregoing discussion was addressed primarily to distribution of hard-copy MOTD. Microfiche varies the process somewhat. Instead of the SHAPM tasking NPPSO to prepare the microfiche, it tasks NSDSA. NSDSA then prepares the microfiche shootup sheets and tasks a NPPSO branch office (NPPSBO) dedicated to microfiche production to develop the manual. When the NPPSBO has produced the microfiche version of the MOTD, it distributes them in accordance with the SHAPM approved distribution list with labels supplied by NSDSA. The working microfiche final master is returned to NSDSA for archival storage.

There are four basic methods for users to request resupply of data: (1) sending a letter of request on the ship's letterhead to the stocking activity; (2) sending a Drawing Request/Transmittal, NAVSHIPS 9022/1 to the stocking activity; (3) sending a DD Form 1425, Specifications and Standards Requisition to NPFC; and (4) Requisitioning by MILSTRIP procedures (DD Form 1348) to NPFC. Almost all MOTD stocked at NPFC is obtained through the use of MILSTRIP procedures. User requirements can be identified by use of NAVSUP 2002 and the ship Technical Document Index (TDI). Any requests for resupply action sent to the offices of NSDSA are converted to the proper format and forwarded to the cognizant supply activity. In addition, the requestor's organization address is entered into the STEDMIS distribution file so that all further activity relative to that particular document will be sent to the requestor automatically as it becomes available. Using activities may also request they be put on "automatic distribution" for MOTD which they feel they need by simply notifying NSDSA. The point to be made about "one-time" distribution of NAVSEA MOTD is that almost all resupply comes from NPFC through MILSTRIP action. This action does not guarantee that a requestor will be placed on distribution for future changes and updates, but only that the data he has requested will be processed through normal Navy supply channels. Any problems a user may have with identification or acquisition of a particular type of data can be directed to NSDSA for resolution.

Archive activity within the NAVSEA distribution system takes two basic forms, depending on the current utilization of the equipment it supports. Copies of technical data for equipments in active use are maintained in a file at NSDSA. This file is essentially a library on all released NAVSEA MOTD in hard-copy or microfiche form. (At present, hard-copy data is not

reduced to microform.) In addition, a repro-master of each manual is retained as a backup to the one stored at NPFC. Archive copies of manuals for obsolete equipments are sent to the Federal Records Center for permanent storage.

In general, the distribution functions of NAVSEA are the same as those of NAVAIR. However, the NAVSEA operation does not have the manpower dedicated to the tasks to be performed, as does NAVAIR, and consequently does not provide the level of performance in some of the distribution functional areas. Also, NSDSA is in the early stages of its organizational and functional development and has not been able to provide support at greater levels, probably due to funding limits. This should improve as NSDSA develops, and programs such as STEPS are implemented and functioning as planned.

3.6.4 CURRENT NAVELEX MOTD DISTRIBUTION SYSTEM

NAVELEX distribution policies for MOTD, like NAVAIR and NAVSEA, are primarily designed to provide initial deployment in conjunction with equipment deployment. Changes, update, and user requests for resupply action are handled through normal Navy supply channels utilizing MILSTRIP procedures.

Responsibility for management and control of the NAVELEX distribution system for MOTD is under the cognizance of the Logistic Directorate, Code 04. The performing organization is the Training and Publications Systems Division, Code 04F3, of San Diego, California. Three groups comprise this division with responsibility for distribution residing in the Technical Publications element. General policies and guidelines applicable to TM distribution are contained in NAVELEXINST 5600.4, Naval Electronics System Command Technical Manual Management Program. NAVELEX also utilizes NAVSEA instruction and specifications, such as NAVSEAINST 5600.8, where applicable.

The establishment of initial distribution requirements essentially begins with the assignment of TM numbers to facilitate configuration control. (See figure 3-48.) TM number assignment generally occurs subsequent to the second in-process review (at approximately the 70-percent completion point) and after DCASR approval of the preliminary MOTD has been received. NAVSEA performs the TM numbering and indexing function for ELEX 04F3 by providing a block of TM numbers. In addition, NAVELEX utilizes the NAVSEA STEDMIS/STEPS data management system for status and reporting of TM configuration and disposition. (Information on the STEDMIS/STEPS data management system is contained in topic 3.6.3 of this report and NAVSEAINST 4000.4.) Once the preliminary TM is validated, it is delivered with the first article delivery for first article testing. After it passes the first article test, verification occurs. Once the camera-ready-copy (CRC) of the final MOTD is ready, it is inspected by DCASR, who in turn authorizes NPPS to print with funds previously allocated. The printed copies are then returned to the contractor for packaging with the deliverable equipments and distribution. NPPS through its printing subcontractor often handles distribution other than the copies packaged with the hardware.

The quantitative distribution requirements of NAVELEX MOTD include providing two manuals with each deliverable equipment, so the distribution requirements established for the equipment by the acquisition program manager are also applicable to the data. The quantity of manuals to be placed in storage at NPFC and any special distribution, such as for training, is determined by NAVELEX utilizing the guidelines of NAVSEAINST 5600.7, enclosure 3, for bulk quantities and special requests from the APM or activities with requirements. The data being deployed to the fleet is packaged and deployed with the deliverable equipment by the contractor. If only preliminary data is available at the time of deployment, it is sent out with the equipment. It then becomes the responsibility of the contractor to see that this data is replaced by the final version when it becomes available. Any missing manuals at the time of equipment deployment are replaced through normal resupply channels. Changes and revisions to existing manuals are prepared by the contractor, or other preparing activity, printed by a local NPPSO and sent directly

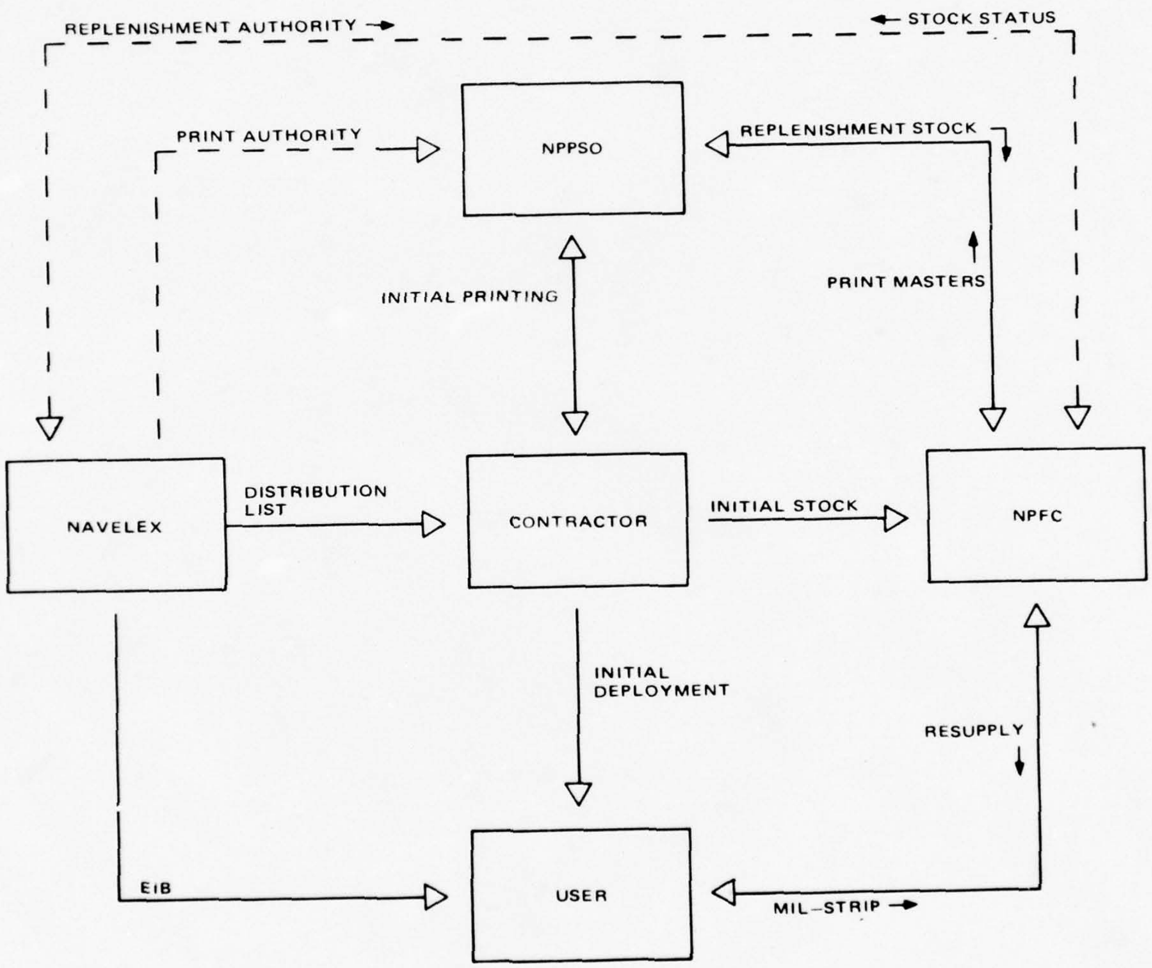


Figure 3-48. Functional Flow of the NAVELEX Distribution Process. Initial distribution of new data is accomplished in conjunction with equipment deployment by the contractor. Changes, updates and resupply is accomplished through Navy supply channels via MILSTRIP.

3.6.4 CURRENT NAVELEX MOTD DISTRIBUTION SYSTEM (Continued)

to NPFC. The distribution of these items results only from users' requests. Users are notified of the existence of such data by the NAVELEX-published EIB. Field Change Bulletins (FCB), which may include TM revisions or changes, are not stocked at NPFC, but distributed from the contractor to only those activities undergoing change.

NAVELEX procedures for resupply of MOTD to fleet users follows the same basic criteria as that of NAVSEA. Almost all resupply requests go through normal supply channels utilizing MILSTRIP procedures. All requests processed by MILSTRIP are sent directly to NPFC, although any received by NAVELEX 490 will be forwarded to the proper supply center. Replenishment of NPFC stock is by authority of NAVELEX. Normal routine calls for NPFC to notify NAVELEX of the existence of an inadequate on-hand balance of a particular item. NAVELEX then projects future demand by analysis of past requests and potential utilization of the subject equipment. If additional stock is required, NAVELEX requests the repro-master to be withdrawn from NPFC inventory and authorizes the printing of a specific quantity for resupply stock.

Functionally, NAVELEX is comparable to the other SYSCOMs in its distribution activities. Operationally it nearly duplicates NAVSEA, using the same documentation and having similar, but more limited, organizational support.

3.6.5 CURRENT ARMY DISTRIBUTION SYSTEM

Distribution of Army technical publications consists of two major phases, initial distribution and resupply. There are two methods of initial distribution, pinpoint distribution and command distribution.

Army Regulation AR 310-2 defines the types of Department of the Army (DA) agency and command publications, their numbering and the distribution of DA publications. Army publications can be categorized as administrative publications, training and organization publications, and technical and supply publications.

MOTD used by maintenance personnel would mostly be categorized as technical and supply publications. This group of MOTD consists of Technical Manuals (TM), Technical Bulletins (TB), Lubrication Orders (LO), Modification Work Orders (MWO), Supply Bulletins (SB), Supply Catalogs (SC), Depot Maintenance Work Requirements (DMWR), Firing Tables (FT) and Trajectory Charts (TJC).

The Army publication distribution system includes MOTD publications as well as all the other categories of publications and forms. Distribution is in two phases: initial distribution and resupply. Initial distribution is the first issuance of new and/or revised publications. It is made to all units on an "as needed" basis. Resupply is providing publications to the units after initial distribution has been made.

The Adjutant General has the responsibility and establishes policies and procedures to provide an adequate initial supply of DA publications to commanders of all elements of the Department of the Army. Maintenance of adequate stocks of publication is part of the Adjutant General's responsibility.

To provide distribution, the Adjutant General established single source publication centers, US Army Adjutant General Publications Centers (USAAGPC) in the United States. One is in Baltimore, MD, and the other is at St. Louis, MO. The center at St. Louis is responsible for world-wide initial distribution and resupply of all technical and supply publications, such as technical manuals, technical bulletins, lubrication orders, supply bulletins, and supply catalogs.

Pinpoint Distribution: This is one method for initial distribution and resupply of MOTD to world-wide activities from a USAAGPC. The method is based on the use of requirements or "subscription" forms (DA Form 12 series) to define the types and numbers of technical publications needed at the activity. The using activity completes the forms and then "subscribes" for these publications by sending the forms to the USAAGPC. The procedure is similar to the NAVAIR Initial Outfitting and subsequent automatic distribution requirements method. The USAAGPC assigns an account number that identifies the activity that submits pinpoint forms. Then whenever publications are received at the USAAGPC they are forwarded to that activity. The activity establishes this account by completing DA Form 12 (Request for Establishment of a Publications Account) and sending them to the center with the initial submission of the pinpoint subscription form. Accurate completion and submission of the subscription forms is the responsibility of the activity commander. The publication distribution to that unit depends upon the accuracy and currency of its requirements recorded on those forms.

Command Distribution: This is another method of initial distribution and resupply through a system of installation publications stockrooms and overseas publication centers. In the United States, these publications stockrooms are provided with bulk quantities of publications for initial distribution to those units and activities serviced by the installation stockroom. The installation publications office determines actual users and numbers of copies for each by using the distribution guidance printed in or furnished with the publication. This distribution is commonly referred to as a "formula" distribution.

Resupply: Any organization with an established account at the USAAGPC may requisition a publication by following the procedures on DA Form 17 and DA Form 17-1. Additional information is contained in DA PAM 310-2 and DA PAM 310-10. Organizations that do not have an account at USAAGPC, forward requisitions to the stockroom servicing their organization.

Service Schools: To obtain existing publications, service schools submit annual requisitions listing all known or forecasted requirements for publications to the USAAGPC not later than 1 March of each year. They must be sent at least four months in advance of the data when they will be used. Service schools conducting courses in operation and maintenance are furnished copies of the Consolidated Equipment Publications Schedule issued by Commanding General, US Army Material Readiness and Development Command (DARCOM). This is a schedule of the expected publication dates for new and revised equipment publications. This ensures that the service school receives publications needed for training in a timely fashion.

Other Military Departments: The Department of the Army has a common service agreement with the Navy, Air Force, US Marine Corps, and the Defense Supply Agency (DSA). Policy and procedures for the exchange of technical publications are contained in AR 310-71, NAVMATINST 5600.7, AFR66-42, MCO5600.38, and DSAR 5025.17. Requisitions are submitted on DA Form 17. Requests for Navy publications are sent to Navy Publications and Forms Center (NPFC). Requests for Air Force publications are forwarded to the nearest Air Force installation by letter, telephone, or submitted in person. Or a DD Form 1149, Requisition and Invoice/Shipping Document, can be sent to the Air Force Publications Distribution Center. Requests for Marine Corps publications are submitted to the Commandant, USMC, ATTN: Code HQSP. Requests for DSA publications are submitted to the publications officer of the nearest DSA field activity.

The overall impression of the Army distribution system is that it is effective and appears to be working well. Similar to the Navy, the Army's "subscription" method provides for automatic distribution of MOTD to the users and also requires that each individual unit/activity has responsibility for complying with DA policies and procedures and ensuring that they have adequate MOTD.

3.6.6 CURRENT AIR FORCE DISTRIBUTION SYSTEM

The Air Force Technical Order (TO) System is used to disseminate military orders of a technical nature. The management and distribution of the Air Force TOs is a technical service responsibility of Air Force Logistics Command (AFLC).

Technical Orders (TO) are published and distributed by the Air Force Logistics Command (AFLC) under the authority of the Secretary of the Air Force in accordance with AFR8-2. Air Force TO 00-5-1 defines the concept and management of the USAF Technical Order system as established by AFR8-2. The Technical Order distribution system is defined in TO 00-5-2 and contains policies and procedures for use by the USAF in obtaining MOTD.

The distribution and management of MOTD is a technical service responsibility of AFLC. Air Force MOTD is not considered a commodity of the supply organization. Logistics management of TOs is performed at the AFLC Central Computer Center for G022 ADP systems located at Oklahoma City Air Logistics Center (ALC). The Centralized Inventory and Requirements System (G022A) is part of the Logistic Management of TOs and provides management of requirements, stock balance, requisitioning and distribution functions of Air Force TOs. A Technical Order Logistic Subsystem (G022C) is located at each ALC. There is a daily interface between these Technical Order Distribution Control Activities (TODCA) and the G022A System master record at Oklahoma City. Technical Order Distribution Offices make requirements and requisitions inputs to the centralized system by AUTODIN or AFTO Form 187 in accordance with TO 00-5-2.

The specialized responsibilities pertaining to Technical Orders are:

1. San Antonio ALC for distribution and backup stock inventory control of special weapons TOs.
2. Ogden ALC for distribution and backup stock inventory control of non-nuclear explosive ordnance disposal TOs.
3. Oklahoma City ALC for distribution and backup stock inventory control of AFLC TOs, Numerical Indexes and Requirements Tables.
4. Oklahoma City ALC is the Air Force central management office for TO numbering and indexing, ADP master file establishment and maintenance with current indexing and TO status information, management of TO symbols, coordinating Joint Interest Listing Air Force indexing data with the Navy, and coordinating with HQ, AFLC and ALCs to accomplish these functions.
5. Oklahoma City ALC is the central management office for TO distribution codes, ADP initial distribution requirements, ADP requisitions, inventory addressing and product processing on operational systems at the Air Logistic Commands.

Initial Distribution (ID) is the first distribution of MOTD after the initial printing. After ID is made, that technical manual may be obtained by requisition only. The ID is based on information from the Numerical Index and Requirements Tables which has been established in the G022 ADP system at the Central Computer Center at Oklahoma City Air Material Area. Preliminary TOs are distributed by the appropriate TO DCA under a cover letter and in

accordance with AF TO 00-5-1 and TO 00-5-2. After the ID requirements have been established by the TODO, future changes and revisions for the TODO copies will be received by automatic distribution.

The typical Initial Distribution cycle is shown in Figure 3-49. The flow originated from the MOTD users and ends when they are provided with MOTD. USAF approving agency is not necessarily included in every ID cycle, but can be included whenever approval is needed. The distribution source (warehouse, etc.) is shown as a separate entity, but at some commands, it may be combined with the Technical Order Distribution Office (TODO). Another command may combine the TODO and the Technical Order Distribution Control Agency (TODCA) as one entity. In the cycle shown, the surplus or backup stock is shown as returned from the distribution source and stored at the TODCA. This is not an absolute, but is a command prerogative. Some commands may store the backup stock in the distribution source.

As an ID, the flow of the Requisition distribution cycle can begin and end with the MOTD users. In general, the flow is the same as in the ID cycle. The Distribution Source is not shown as a separate entity, although it may exist as such, but that function is part of the TODO. The principal difference in the requisition cycle, compared with ID cycle, is the path of the manually prepared requisition form. It bypasses the mechanized system (G022) and is forwarded to the Technical Order Distribution Control Agency (TODCA).

Communication methods are not shown in the distribution networks because of the number of variations that can be used to cover all the situations. The principal methods used are AUTODIN, AUTOVON, telephone, electrical message, manually prepared forms and letters.

MOTD distribution is a small, but important part of the mechanized logistics management of Technical Orders. The primary function of the mechanized system is to provide USAF with logistics management capability and a technical service to support training specialists in the commands and other authorized using activities.

Like the Army and Navy distribution systems, the Air Force system appears to be working well, performing its job. The principal difference is the degree of automation being used. The Air Force has provided an apparently effective automation of distribution data integrated into their logistics management information system.

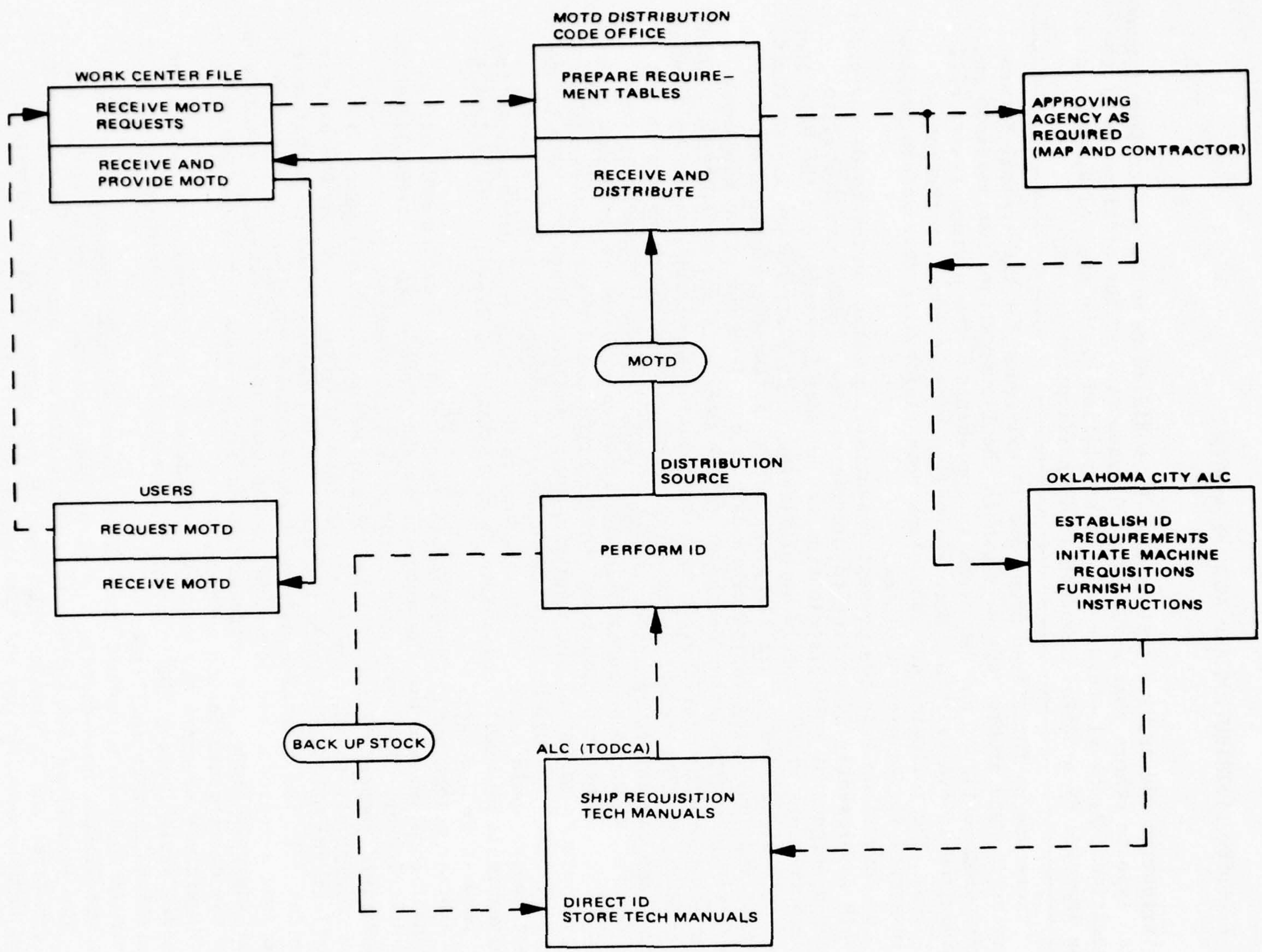


Figure 3-49. Typical Initial Distribution (ID) Cycle. Changes and revisions subsequent to ID are distributed to users automatically.

3.6.7 PROPOSED DISTRIBUTION AND ARCHIVE SYSTEM

The Distribution and Archive systems must be modified as media shifts from a paper-oriented type to others that will allow TM production at the archives or at the user location. Archival storage will be simplified by the new media, and control will be improved by a NAVMAT standard TM identification system.

There are no formalized plans now in existence for the typical future distribution and archive system shown in the illustration. As research and development continues and new media is implemented, the present system will be required to evolve into a more responsive vehicle for distribution and archives. The following are some plans being informally reviewed to provide improvements to the present system.

By converting from the present essentially paper-oriented hard-copy media (NAVAIR is presently converting to microform), the SYSCOMs could utilize improved methods of MOTD distribution to the User Commands, and the bulk storage requirements at NPFC could be eliminated. The distribution system could be greatly simplified by utilizing new media design (microform, video disc, digital) and delivering reproducible data direct from the prime equipment contractor to a replicating center or to the user site for replicating. This would eliminate the distribution problems caused by delayed production funding from the SYSCOMs to NPPSO, the slow reaction of NPPSO to MOTD printing orders, and the delays caused by the slow user MOTD replenishment system.

One method would be to provide the archives with the reproducible data direct from the prime contractor. The archives would then replicate MOTD into the proper media for the requiring user, and distribute the MOTD to the user stations. Because no printing order quantity requirement for cost-effectiveness would exist, as it now does in hard-copy MOTD acquisition, the archives could be highly responsive to any limited on-demand MOTD replenishment request from a user.

Another method being considered is to provide replicating machines at each user location and use the archives as the storage and reproducible data copy distributor. The prime contractor (for in-production equipment) or the SYSCOM Field Support Office (for out-of production equipment) could deliver the MOTD directly to the user locations (plus archival copies to the archive), or deliver the MOTD directly to the archives for distribution to proper user locations. In the case of a user MOTD replenishment requirement, the archives could send a reproducible data copy to the user for replicating. Depending on a cost analysis study, the reproducible data copy could either be destroyed after use or returned to the archives.

Regardless of where the reproducible data is replicated, the use of the new media would improve MOTD storage by removing the size problems imposed on the archival storage facilities.

In response to a request from Chief, Naval Material Command (CNM) in 1974, the SYSCOMs have devised a proposed new standard numbering system for TMs. The guidelines for implementing the system are contained in NAVMATINST 5600 (no date) and in standard Technical Manual Identification Numbering System (TMINS) Description and Application Guide (M0000-00-IDX-000, dated 4 July 1976).

NAVMAT TMINS established a standard method of assigning a unique and significant TM identification number to each individual TM and each separately-bound portion of a TM. The TM ID number may be composed of either of two distinct parts. The first is the publication identifier patterned after the 13-digit National Stock Number, ie, 0000-LP-000-0000, providing unique identification of a TM. The second part of the TM identifier number is a variable length suffix of up to 17 characters to provide security information or specific user-oriented information (applicable equipment designator, recognizable nomenclature, hull number, etc).

Use of the first part is mandatory, but use of the second part is optional, except when the TM is classified or is a separately bound unclassified part of a classified TM.

Instituting TMINS will eliminate the confusion in the fleet caused by the use of different numbering systems in the various Systems Commands. User ordering of replenishment TMs will be simplified, and the standardization of cataloging will improve the TM acquisition and distribution systems and simplify NPFC storage procedures.

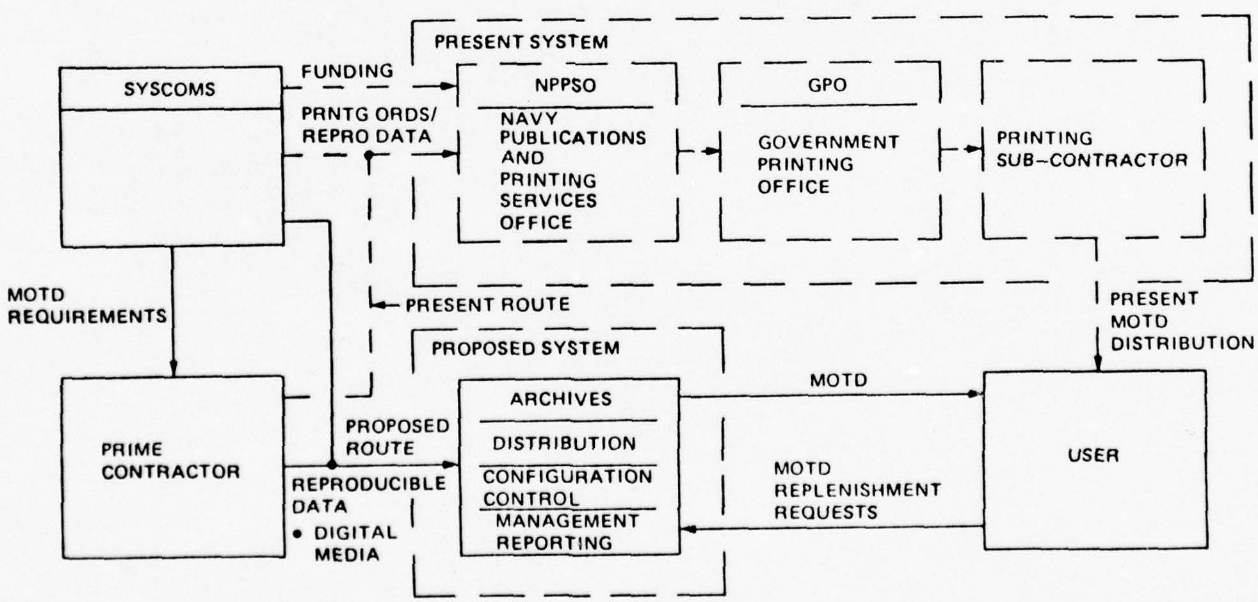


Figure 3-50. Proposed Distribution and Archive Systems. The simplifications indicated are made possible through conversion from paper as a primary medium.

SUBSECTION 3.7
RESEARCH ISSUE 7: FEEDBACK

3.7.1 DEFINITION AND OBJECTIVES OF THE FEEDBACK FUNCTION

An effective feedback system not only has advantages to the user, but benefits those creating and processing MOTD. Information must be gathered (discrepancies identified), communicated back for analysis, then evaluated and measured, reported, appropriate corrective action taken, and the results communicated to those affected (and from whom information was gathered).

Feedback of information, relative to the value of the products of NTIPP, is a necessary requirement to maintain the integrity of the system. Effective feedback mechanisms must contain a set of interrelated and controlled functions that react in a timely manner.

Information-Gathering - The means must be provided to obtain sufficient information and to assure that it is both valid and complete. Since technical information is normally related to a man/machine performance environment, it must be understood that the technical information is secondary to the mission of the activity, i.e. operation, maintenance, overhaul, training. Its "failure" is detected only when it is insufficient to support the man/machine activity. Most data-gathering is related to the primary mission activities, such as in the Navy's Maintenance and Material Management (3-M) System. This type of system, if response is mandatory, provides sufficient amounts of data; however, the "failure" data about the technical information is usually very limited and of questionable validity since the reports concentrate on the equipment/parts data. What can be determined from many of the 3-M type reports are such comments as "Yes, the TM was available," or "the instruction or procedural guide specified has omissions, errors, ambiguities or other deficiencies," but not what was omitted, what the error was, or specifically what was the deficiency.

More direct methods of information-gathering are also available. One method is the current practice of providing in each TM one form (printed on a tear-out sheet in the back of the book) to complete if a discrepancy is noted. This procedure assures that the first discrepancy a user encounters in a TM will be reported, if he is inclined to do so. This is a useful, though limited technique; however, it is a one-shot affair, and as a voluntary feedback system, it is dependent on volunteers. Another direct method is the use of survey questionnaires. This is a good method if specific information is needed and if questions can be constructed to obtain brief, directed data. If it is a voluntary response survey, the validity is always of concern because of the number of responses (few) and the tendency to get responses from "complainers." These factors need to be weighed in the analyses. Also of considerable value if properly conducted, is the person-to-person survey. It is a most valid method providing there is a sufficient sampling of area(s) to be surveyed, if the survey questionnaire has been constructed to obtain the needed data, and if the surveyer (interviewer) has the ability to extract the data from the interviewee. It is also an expensive method of gathering data. All of these methods are being used in the Navy for the purpose of gathering information about the usability of the technical information available to the user. But they are uncoordinated, with each serving a single purpose.

Feedback Communication - The means to communicate the gathered information is the second step in the process. This must be structured to be reactive and timely. The system cannot be effective unless the data gathered is delivered to a point where it can be acted upon within a reasonable timeframe. Current feedback mechanisms appear to be adequate to the needs.

Analysis, Evaluation, and Measurement - These are the necessary processes to extract the meaningful information and, through analytic means, to determine the substance and impact related to a functional or organizational entity. This process can detect trends and forecast potential problem areas, as well as define current status or deficiency areas. The results of the analysis, evaluation, and measurement are then reported to "proper" authority for appropriate corrective action.

Corrective Action - This can be the most time-consuming step in the process. The steps involved in entering a correction into the update cycle until it is issued (distributed) are several, involving different organizations. Corrective action is usually the most blamed delay in the cycle. These processes appear to be weak in the current scheme of the feedback issue, at least insofar as reaction time is concerned. From the time a technical information "failure" is detected (or information gathered) until it is corrected (usually via a TM change), *six months to a year is not an unusual* response time that can be expected from the current systems.

Acknowledgement - Reporting back to the source of the information (discrepancy) on the action taken is not always done. If not, the principal means for the discrepancy reporter to be apprised of the disposition of his report is when the change documentation arrives. This may be essentially adequate, except that the various organizational elements involved in the gathering, communicating, analyzing, and reporting processes are not informed if action is taken, or what action. The loop is not really closed. Although not essential in getting the job done, it is a strong contribution to reinforcing the value of a feedback system with those most involved - the users. They will use it if they know it works.

The entire feedback process has definable value to the entire NTIPP process of developing, preparing, producing, replicating, and distributing as well as to the user and the use of technical information. All functional areas need to be informed of their "failures" and, if possible, their successes, in order to continually refine the competence (and product quality) of each function. If properly structured, a timely, coordinated, controlled, and dedicated mechanism for feedback of data on technical information, technical accuracy and completeness will serve that need and help to provide usable MOTD to the user.

3.7.2 ASSESSMENT OF CURRENT NAVY FEEDBACK METHODS

The Navy presently has a mixture of technical information discrepancy reporting methods, with each SYSCOM taking a separate approach to its feedback system.

As described in the preceding topic, there are several methods of gathering feedback, coupled to essentially the same methods of processing the data that is gathered. One method used is not dedicated specifically to the technical information but serves only as TM deficiencies relate to other operation and maintenance activities such as the Maintenance and Material Management (3-M) system.

3-M System for MOTD Discrepancy Feedback - 3-M, while accumulating data on the performance of Navy maintenance activities, provides some information on the relationship of the technical information to the successful performance of maintenance. On the principal form(s) used to report maintenance "(Automated) Ship's Maintenance Action Form," OPNAV 4780/2Q or OPNAV 4790/2K, is space (Block 8) to include the cause of the maintenance action. Among the causes that can be reported are: Code 3, Lack of Knowledge or Skill; Code 4, Communications Problem; and Code 5, Inadequate Instruction or Procedure. Any of the three could be technical-information (MOTD) related, although Code 5 is specifically related to the inadequacy of the "instruction or procedural guide." Since there is little or no chance for a description of the deficiency on the form, there is no way to analyze the technical information problem - or to establish that it is even a real problem. The other data about the technical information that is provided on the form is whether or not there was onboard technical information covering the maintenance action. This is important, since nonavailability of technical information shows a breakdown in the system, although not what broke down or where it occurred. It could not be learned to whom in the SYSCOMs publications management the technical information discrepancy data was being reported by the 3-M program or what was the disposition of the data received. It appears it has little use at the present time.

NAMP Approach to Discrepancy Reporting - NAVAIR participates in the 3-M program, but also operates an Unsatisfactory Report (UR) system as part of the Naval Aviation Maintenance Program (NAMP). The UR system is a mandatory system that relies on the response of the user. In its present structure, there is no specific publications UR and reports of technical information "failure" normally do not contain explicit failure data. This is being changed in the present switchover from the UR to the "Discrepancy Report (DR)" system instituted in early 1977. DR is a system dedicated to collecting, evaluating, solving and reporting problems users have encountered with NAVAIR MOTD. As with most systems, the DR system specifies corrective action time periods. The Rapid Action technical information UR must be corrected immediately by message if it is a critical safety problem, or within 30 days if not. The routine UR is normally corrected during the next publication update or within 90 days.

MIARS Uses Feedback to Improve - There is also a feedback system for the NAVAIR Maintenance Information Automated Retrieval System (MIARS). This is a voluntary reporting system using a deficiency reporting form specifically developed for user comments. Most of the comments, on the few forms that are reported to be received, deal with TM loading of cartridges (e.g., why is X-TM

loaded with Y-TM in the same cartridge?), the paper not working, and other nontechnical-information defects. Comment level, although low now, was high in the early years of the MIARS program and was a contributing factor to the refinements of the system.

TMDER Used for NAVSEA Deficiency Evaluation - The other formal Navy system is the use of the TM Deficiency Evaluation Report (TMDER) which is part of the Quick Reaction Technical Manual Modification System (QRTMMS) of NAVSEA. The primary reporting vehicle is the TMDER form (Replacing the User Activity TM Comment Sheet). There are three levels of deficiency - Emergency, Urgent, and Routine. Both reporting and corrective action react to the deficiency level. Deficiencies determined by the reporter to be Emergency (personal safety) and, at times, Urgent (equipment or property endangered) are reported using "emergency" procedures for communicating the discrepancy and the corrective action is reported back the same way. Routine is handled using "routine procedures." Response time for Emergency is set at three days, Urgent at 10 days, and Routine at 90 days after receipt of the deficiency report. This is a limited feedback technique which is not as yet systematized, and is structured to be reactive to each form submitted. The system still depends on volunteer action, and it is not as yet coordinated with the total technical information functional process.

NAVELEX User Activity Comment Feedback - A system very similar to that described above, NAVSEA's TMDER, is used by NAVELEX. Their form, two copies of which are found in the TM, is the User Activity Comment Sheet formerly used by NAVSEA. The responses are reported to be few in number, and the system is not considered to be too effective. However, NAVELEX intends to concentrate an effort on improving their discrepancy feedback system in the near future.

Person-to-Person Data Gathering - The current HAC program, Fleet Survey of Technical Manual Users, is a special program. If fully extended (it presently is limited to elements of the Pacific Fleet), it could provide the most significant data to be accumulated, analyzed, and reported in recent years. Its limitation is that it is a one-shot effort and the data gathered is only currently valid. It should be repeated periodically such as is done by NAVAIR twice a year in their fleet visits to survey selected areas of interest.

Feedback Systems Need Control - As with all of the other feedback data gathering activities, even the most effective can lose its value and impact by a failure in the rest of the system. If the system is slow in communicating or uncoordinated in its analysis and reporting, or ineffective in its corrective action mechanism, or fails to follow up with the reporting activity - then the total system can collapse. The Navy has begun to provide some feedback mechanisms dedicated to technical information reporting, but should consider a centralized controlled approach in developing the kind of feedback system with maximum benefit to the user and the NTIPP.

Basically, the current methods of obtaining technical information discrepancy data feedback in the Navy are in part similar to those of the Army and Air Force, discussed in the following topic. Except for the special efforts, like the HAC Fleet Survey of TM users, the Navy has a mixture of dedicated systems and those that outfall from systems really designed to track maintenance actions, hardware failures, and safety statements.

3.7.3 ASSESSMENT OF OTHER CURRENT FEEDBACK METHODS

There is some parallel of Army and Air Force feedback methods to those of the Navy as they relate to technical information deficiency reporting, but there is a difference in that they are singular, dedicated systems.

The Army and the Air Force have feedback systems dedicated to obtaining failure data on technical information only. Each takes a different approach in their implementation and operation, but they are reportedly satisfactory systems.

Army TAMMS and Air Force UR Systems - Army and Air Force maintenance activities also have maintenance management systems that feed back data on maintenance to a central location. These systems also provide some data on the relationship of the technical information to the maintenance action, similar to the Navy 3-M system. As with the Navy, these systems are designed around the man/machine operating and maintenance environment and not the technical information. These systems, The Army Maintenance Management System (TAMMS) and its implementing procedures in the Commodity Commands, and the Air Force Unsatisfactory Report System parallel the processes as described for similar Navy systems.

Discrepancy Reporting of Army TMs - The Army's principal means of feedback of technical manual deficiencies is by the use of a user discrepancy report form (DA Form 2028) now included in the Army TMs. This is a tear-out form similar to the TMDER used in NAVSEA; however, three copies are now being furnished in each TM. The system has mandatory response - receipt must be acknowledged in five days and response made to the submitter in 20 days. Corrective action is immediate for emergency or urgent deficiencies (usually by message) and routine can be accomplished in the next TM update. The action point is through a designated office in each of the Army Commands. The system is reported to be working well for the Army. It is monitored by the Army Maintenance Management Center periodically, but they do not have a specific role in the system. It is a mandatory system depending on voluntary action and, although working well, needs to be "primed" on occasion by those in authority, particularly the corrective action cycle.

The Air Force Uses TOIRS for Feedback - The Air Force has a dedicated system, Technical Order Improvement Reporting System (TOIRS) that uses AFTO Form 22 as the reporting vehicle for most AF technical orders. A different form (AF Form 847), is used for Flight Manual Program publications and Nuclear Weapon Delivery Manuals. AFTO Form 22 and AF Form 847 are not found in the TOs, but are available to users of the manual. TOIRS is also a mandatory system being input on a voluntary basis and follows closely in its communicating and corrective action mechanisms to that of the Army, except there is no response to the submitter. The corrective action response times are 2 days for Emergency, 30 days for Urgent, and 60 to 240 days for Routine (usually as part of a normal TO revision). Corrective action is the responsibility of the cognizant activity such as the Air Logistics Centers for deployed systems and equipment The system is reported to be working well with the major weakness being the corrective action cycle. Headquarters, AFLC, uses the reports, which are automated, as a source of publications management data. Deficiencies by system, class equipment, type or class of error are among the data items that are extracted for analysis.

In general, both the Army and Air Force report satisfaction with their systems. They are dedicated, they have some central control, they are being used as a management tool; however, since they are systems relying on voluntary action, it is questioned that there is sufficient feedback of other than emergency or urgent deficiencies. The routine could be ignored.

Commercial Uses of Feedback Systems - In limited research of commercial operations there was no apparent use of dedicated technical information deficiency data feedback. The automobile companies, airlines, utilities and contractors' field support activities all have some manner of reporting systems for maintenance actions or parts control, but not MOTD. Many commercial applications of feedback are less complex than those of the services. However, many also approach maintenance differently than the services. Maintenance personnel are more highly trained and are assigned to perform in areas for which they were trained. Since maintenance has a direct bearing on profitability, commercial concerns have an added incentive. Feedback that does exist is of the "direct action" type. Problems are brought directly to organization that can take corrective action. Although the services have this intent to some degree on their systems, they still must cycle through an organizational/functional morass to get action. Structuring to get to the action point in fastest time possible is another factor for consideration in the MOTD feedback system of tomorrow.

A Basic Comparison of Methods - As reported, the current methods of obtaining technical information discrepancy data feedback in the Navy are in part similar to the methods employed by the Army and Air Force. However, the Army and Air Force have systems dedicated to reporting failures of MOTD and have some central control and monitoring, service-wide. Commercial systems also parallel, but tend to be less formal and more direct. The better features of each need to be further evaluated if a "best" system development effort is to be established in NTIPP.

3.7.4 PROPOSED FEEDBACK METHODS

There are no plans beyond the current SYSCOM approaches to MOTD deficiency feedback, but future developments in technical information production and delivery methods could provide the means to a better system.

In the preceding review of current feedback methods, a number of terms were used in the descriptions and analysis of the functions of the systems. Among those used were responsive, dedicated, communicative, centralized, controlled, mandatory, enforced, and direct. Some of the terms can be applied to all systems, but for a feedback system to be effective, all are needed.

Current Navy efforts are directed at the revised NAVAIR Deficiency Report (DR) system which contains a specified technical information DR form, and the recent redirection of the TM Deficiency/Evaluation Report (TMDER) program now administered by NSDSA for NAVSEA. No information was uncovered on future programs directly applicable to technical information discrepancy reporting beyond the implementation of the DR and TMDER. Final evaluation of the effectiveness of these programs will take time even though the DR program is an enhancement of the UR program and TMDER is redirection of a previous program operated by NAVSEC. The DR program, scheduled to become operational in March 1977, has an analysis scheduled by December 1977. Continual analysis can provide the means to assess their value and determine their worth.

Neither the Army nor the Air Force have plans to change their present technical information feedback systems. Since they feel their systems are working, they have no incentive to change.

In the process of researching feedback methods, those involved with the process express opinions and ideas in regard to the present systems and what is needed. These have been included in the postulation presented below.

The initial factor to be considered is the basic communications structure needed to connect the user (reports of discrepancies) to the source of the technical information. The existing and projected MOTD distribution system is structured to get technical information to the user and provide the necessary controls (from SYSCOMs) and reports of status (to SYSCOMs). One plan offered is to use the distribution communications structure for feedback. In some cases the communications link would be changed to a two-way instead of a one-way channel. Within the long-range digital MOTD processing and delivery systems there could be a direct link to the organizations maintaining the MOTD data bank. This provides a compatibility for a near-real-time, immediate action response system. Status reporting could also be programmed into the system to provide constant current management information.

Information gathering is, as previously stated, a critical area. All systems rely on voluntary action even when the system is mandatory. Even the person-to-person survey needs the interviewee to "volunteer" information. It can be assumed that in any information gathering method the emergency or urgent discrepancies will have a high percentage reported. It can also be assumed that there will be some discrepancies reported informally (outside the structured system). Further, it is questionable how many routine discrepancies are too minor (to the user) to bother with and never reported. The problem is how to get the maximum reporting (100 percent is the goal) into a discrepancy reporting system. Two elements that need to be built in are "ease of use" and "responsiveness." There are others, such as making the importance of discrepancy reporting known by educating and reeducating the

MOTD user periodically. Design and implementation must also be accomplished within some reasonable cost constraint. Since change is slow, it is likely the report form bound into the TM or the separate report form will be around for a while. In fact, it (the report form) will probably be around in the future - in a different form - one that could be communicated via an interactive management device or on the MOTD delivery (distribution) system.

Since the technical information user is key to the initial discrepancy reporting he must stay in the loop to be informed of the corrective action as well as receiving the corrected information. The first, being informed of the corrective action, provides the reporter with input that the system is working (he is getting results) and the second, receiving the correct information, is proof that it worked. The former is not part of many current systems. It has a value to some degree for emergency or urgent discrepancies, making the reporter the action monitor, although corrective action for emergency conditions would be taken as quickly as the reporter would be informed about it. Its most important use is to provide "public relations" to let the reporter (and those he relates to) know he has a working tool to make things better. Completing the loop is an important function that future systems need to provide.

Functions of analysis evaluation and measurement are necessary requirements to define the corrective action, determine its relative importance, and develop a statistical base for further analysis of trends and to isolate or highlight specific discrepancy information. The corrective action function is the mechanism to make the defined correction and get the resultant change information to the user(s). These functions will continue in the future system even though, in the long range, the communications may be digital and interactive. Therefore, these functions, which currently are blamed for the poor response time some systems experience, must become highly reactive.

Looking ahead, the feedback system of the future can be an automated, highly reactive, interactive device to keep technical information totally valid for the user. If the "best" method that can be developed for this purpose is developed, it should be a Navy-wide system. This is a challenge for NTIPP.

3.7.4 PROPOSED FEEDBACK METHODS (Continued)

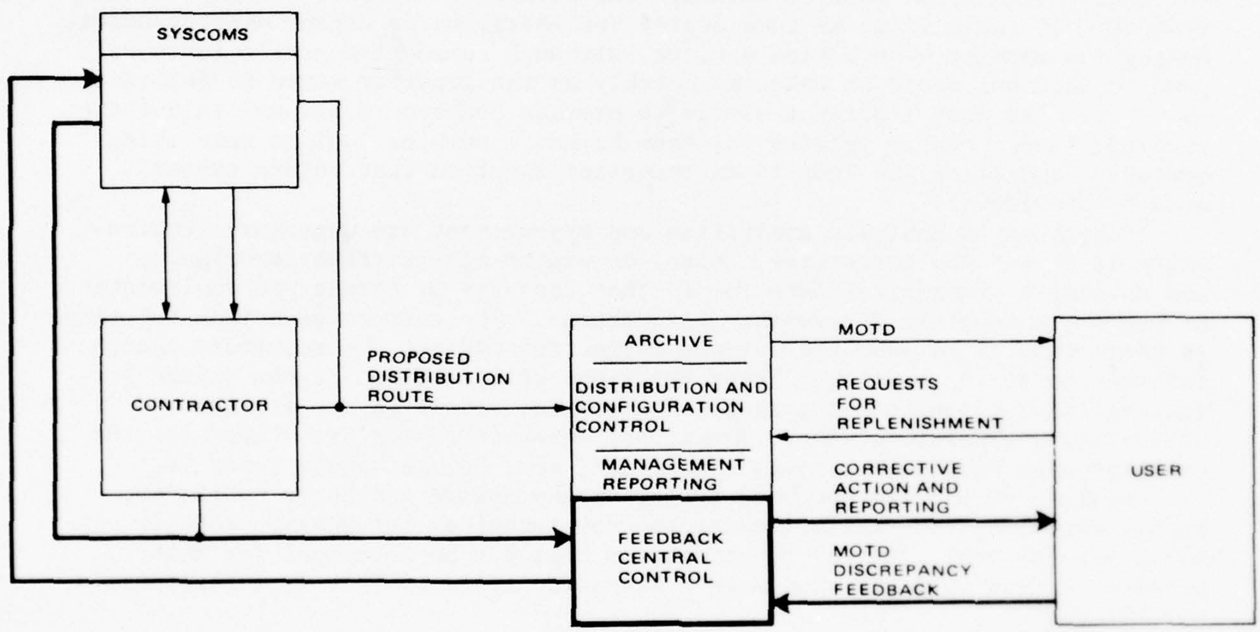


Figure 3-51. Discrepancy Reporting Using Distribution Mechanisms. The basic structure may be usable with some changes and enhancements to accommodate the feedback function.

SUBSECTION 3.8
RESEARCH ISSUE 8: UPDATE

3.8.1 DEFINITION AND OBJECTIVES OF THE UPDATE FUNCTION

Update is a mode of operation of all current TM systems. MOTD updates covering in-production equipment are usually developed by the original equipment manufacturer. However, MOTD updates for out-of-production equipment are generated by the cognizant military agency, often with the help of data houses.

Update Definition - Technical manual updating is the process by which TMs are modified to reflect hardware changes or to correct deficiencies that are not related to hardware changes. (See Figure 3-52.) The Navy vehicles for accomplishing this process are Advance Change Notices (ACNs), permanent changes, interim or formal Rapid Action Changes (RACs) or formal manual revisions.

MOTD updates due to hardware-related factors arise as a result of Engineering Change Proposals (ECPs) or scheduled hardware alterations, while updates due to nonhardware related factors arise as a result of fleet feedback reports and contractor field service reports. Any TM user (cognizant military activity, military in-house preparing activity, or contractor) may identify the need to update a TM. Normally the requirement arises as a result of planned hardware changes, deficiencies indicated by the maintenance reporting system, or feedback reports from using units. Engineering Change Proposals, 3M Maintenance Action/Feedback Reports, Technical Manual Deficiency/Evaluation Reports (TMDER), and Unsatisfactory Reports (UR) are examples of the numerous documents used by the Navy to intiate MOTD updates.

MOTD updates for out-of-production equipment are developed in essentially the same manner by the three Navy System Commands, the Army, and the Air Force. NAVSEA and NAVAIR use their cognizant field activities to generate these updates. Depending on the field activity, production of updates is either automated or accomplished manually. All the military agencies subcontract a portion of their out-of-production updates to data houses. The level of subcontracting is dependent upon cognizant field activity staff size. In the case of NAVELEX, the subcontracting of this function to data houses is total.

Navy System Commands procure virtually all MOTD updates covering in-production system/equipments from the original manufacturer. However, the Army and Air Force develop some in-production updates internally, while using the original system/equipment manufacturers for others.

Update Objectives - Hardware-related MOTD updates are intended to present the user with information that reflects the current configuration of the system/equipment which he is to maintain or operate. Nonhardware related MOTD updates are intended to improve existing MOTD by correcting technical inaccuracies, providing additional information where inadequacies exist, or modifying ineffective methods of presentation or TM organization. Providing the user with current and improved MOTD increases system/equipment operational availability and decreases the time required for maintenance.

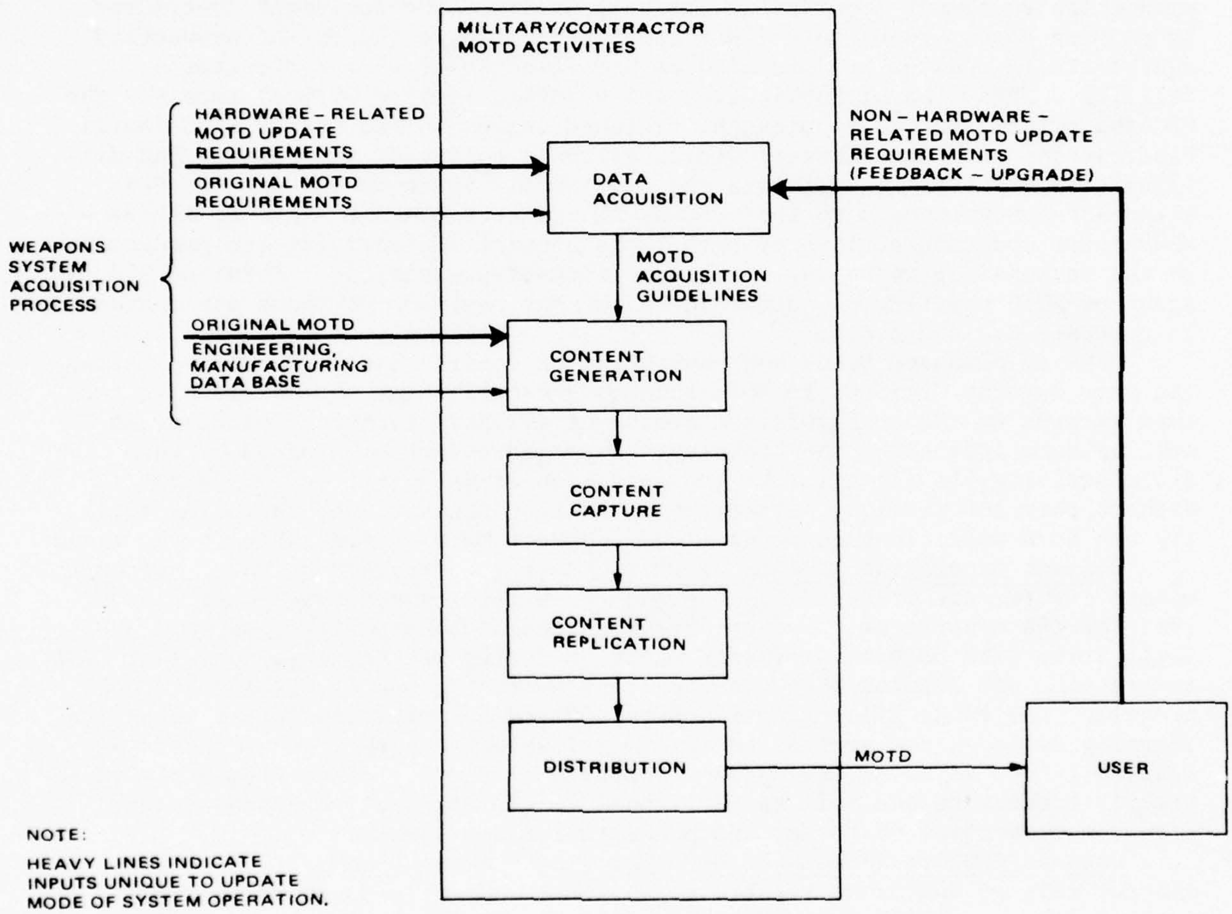


Figure 3-52. MOTD Update. MOTD updates are developed in essentially the same manner as original MOTD.

3.8.2 PRESENT CONDUCT OF THE UPDATE FUNCTION

Updating of technical manuals on in-service equipment is managed differently by the Navy Systems Commands for the in-production and out-of-production life-cycle phases. The updates can be the result of planned hardware-related changes or the reaction to user-reported nonhardware-related deficiencies.

Data Acquisition Aspects of MOTD Updating - Figure 3-53 illustrates the basic interfaces involved with Technical Manual (TM) updating. The in-production equipment acquisition activity utilizes the equipment contractor to produce camera-ready copy (CRC) updated TMs, while the out-of-production equipments TM updates are prepared either in-house or at a contractor's facility. NPPSO (Naval Publication and Printing Service Office) receives the CRC and prints and distributes the finished copies to the user. NPFC (Naval Publications and Forms Center) stores all bulk copies of the changes and distributes any future requests via the Navy Supply System. The user directs all discrepancy reports to the SYSCOMs TM agencies (NAVAIR - NATSF, NAVSEA - NSDSA) for updating actions by either the acquisition activity (in-production) or the responsible technical activities (out-of-production). Detailed discussions of MOTD updating as performed by the Navy Systems Commands are contained in topics 3.8.3 and 3.8.4.

Lack of adequate funds and configuration control are key problems facing the Navy Systems Commands in MOTD updates. Establishing and maintaining accurate records on the configuration status of all Navy technical manuals, as well as data indicating the technical manual inventory maintained by each field activity, is essential to the operation of an effective TM system. Without this information, neither the procuring activity nor the using activity can have sufficient confidence that current MOTD is available in the field.

Content Generation Aspects of MOTD Updating - Programs on which periodic update efforts are procured (as opposed to on-going sustaining) create problems for the contractor. System/equipment technical expertise, as well as familiarity with MOTD requirements built up during the period of original MOTD generation, are diluted when the cognizant writing group is disbanded. Additionally, the funds allotted for update efforts do not allow for an extensive learning cycle on the part of new personnel selected solely on the basis of availability. As a result, updates deployed in the field are frequently technically inadequate and fail to correspond to the original technical manual from the standpoint of format and presentation approaches.

Content Capture Aspects of MOTD Updating - Automation of the internal content capture functions related to update of out-of-production equipment publications at NAVAIR and NAVSEA has existed for some time, while NAVELEX has not yet begun internal automation. To date there has been no command approach or common system; each SYSCOM has developed its own (NAVAIR - TRUMP and NAVSEA - ADPREPS). Yet, despite the apparent differences, technology has dictated a large degree of functional compatibility. Also, unlike the Army and Air Force, the Navy has the SYSCOM-level authority and the existing systems from which to grow. Refer to Subsection 3.4 of this report for detailed discussions of the content capture aspects of MOTD updates.

At present, all the SYSCOMs use hardcopy TMs, but NAVSEA and NAVAIR are also utilizing microform media. NAVAIR is using microfilm with MIARS (Maintenance Information Automated Retrieval System) and NAVSEA is converting to a microfiche media for TMs. These different media must be considered when performing update to TMs as there will normally be different format and type size requirements between hardcopy and microform.

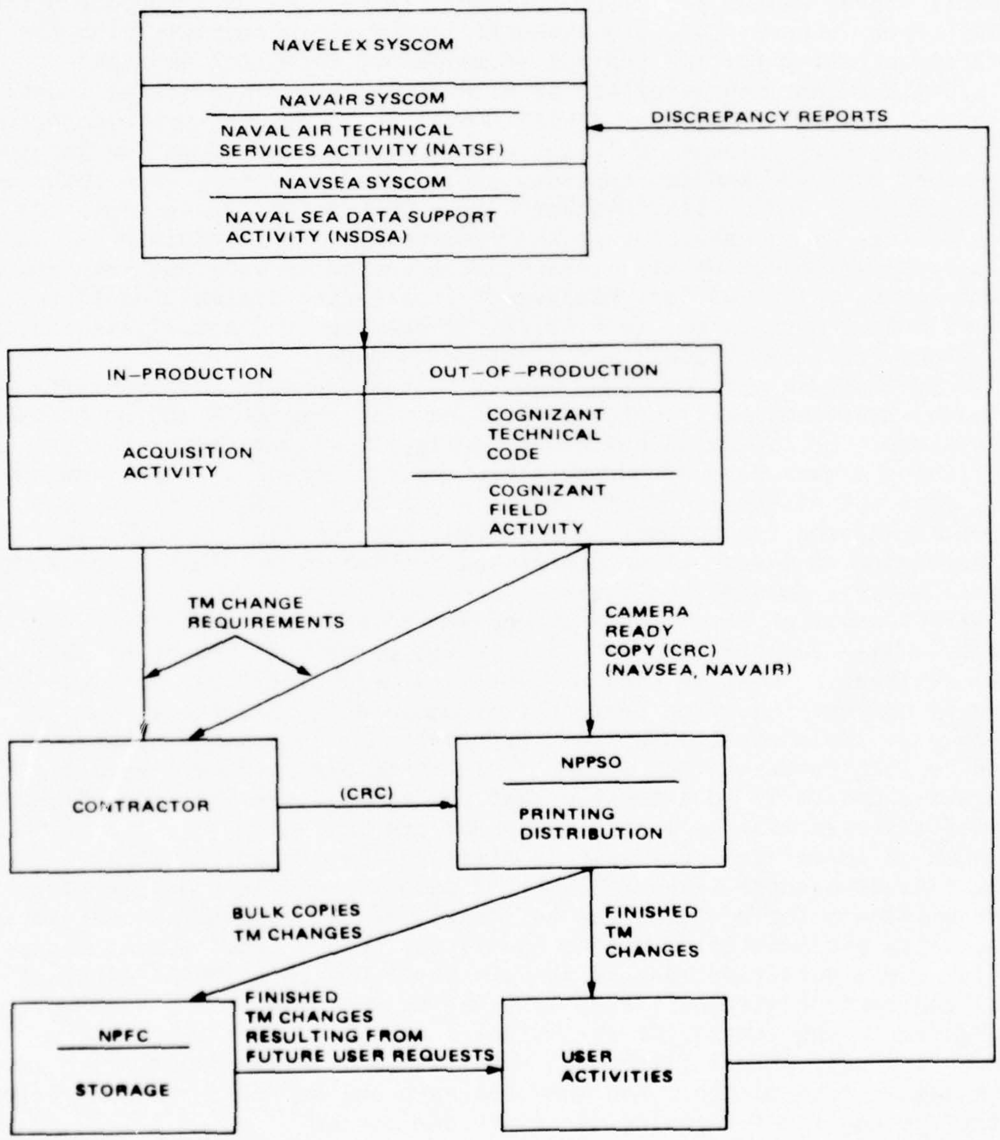


Figure 3-53. Present Update Function. Each SYSCOM uses essentially the same methods to accomplish TM update.

3.8.3 NAVSEA AND NAVELEX UPDATE FUNCTIONS

NAVSEA has established a centralized TM system that manages a configuration control function and monitors and approves all TM updates while NAVELEX uses cognizant field activities to perform these functions.

NAVSEA SYSCOM - The NAVSEA Logistic Support Program Division (SEA 046) is the single headquarters organization responsible for the management of the Technical Manual Management Program (TMMP). Naval Sea Data Support Activity (NSDSA), Port Hueneme (Code 5700-NSWSES) is the shore activity with the central responsibility for the control of shipboard technical manuals.

NSDSA has the responsibility of maintaining the STEPS (Ships Technical Publication System) located at NSWSES (Naval Ships Weapons Systems Engineering Station), Port Hueneme, California. STEPS is a configuration management system that evolved when two separate configuration systems were combined - STEDMIS (NSWSES) and ORDLIS (Concord, CA). ORDLIS (Ordinance Logistics Information System) was a data storage and retrieval system containing a configuration accounting record of all nonexpendable weapon systems and components. STEDMIS (Ships Technical Data Management Information System) identified Navy-owned technical data in the form of ship's drawings and specifications, plus hull, mechanical, electrical, and electronics data.

To further enhance the STEPS Master File and ensure the integrity of the data base, coordination is being maintained with the SECAS and FOMIS information systems. SECAS (Ships Equipment Configuration Accounting System) is establishing a data base of current ship configurations (systems and components) plus the status of modifications and changes. FOMIS (Fitting Out Management Information System) is a system that contains specific ships material allowance in a data base located and maintained at SPCC (Ships Parts Control Center), Mechanicsburg, VA.

NAVSEA utilizes three types of changes to perform updates to technical manuals (TMs) - Advance Change Notice (ACN), permanent change, or complete manual revision. ACNs are used to correct a deficiency that must be corrected to prevent injury to personnel or equipment. Permanent changes require page replacement, addition, or deletion. A permanent change will be issued to incorporate an ACN within a six-month period from issuance. When a projected update is so extensive that new manuals are most cost effective, a manual revision will be issued to update the TM.

When an in-service equipment is still in the production stage, the acquisition manager has the responsibility of maintaining the updating of all TMs. The requirements for updating can be identified and reported by any activity, but normally are identified by the contractor by ECP (Engineering Change Proposal). The acquisition manager answers the ECP with a TMCR (Technical Manual Contract Requirement) that is reviewed and approved by NSDSA prior to being given to the contractor for action. If the TM updating is to be accomplished in-house, a TMSR (Technical Manual SEATASK Requirement) is generated by the acquisition manager, and then reviewed and approved by NSDSA prior to funding the cognizant technical activity for action.

For an in-service, out-of-production equipment, a cognizant technical activity (NSWSES, NAVSEC) is responsible for any TM update. If the update is to be performed in-house, a TMSR must be reviewed and approved by NSDSA before the change can be accomplished. If the update is to be accomplished by a data house, the TMCR must be approved by NSDSA prior to authorizing the contractor to proceed with the change. At present, approximately 50 percent of NAVSEA TM changes are accomplished at contractor facilities.

User feedback is a critical interface in identifying update requirements for all in-service equipment. This feedback is channeled to NSDSA via feedback reports (speed letters, naval message), 3-M Maintenance/Feedback Reports from Naval Sea Support Centers, and TMDER (Technical Manual Deficiency Evaluation Reports). The majority of deficiencies are classified routine and are reported on TMDER forms, while all urgent or emergency priorities are sent via speed letter or naval message. An emergency priority requires immediate correction to alleviate conditions that could cause injury to personnel, extensive damage to equipment or property, or an inability to maintain equipment in an operational condition. An urgent priority requires prompt correction to alleviate a condition that could result in damage to equipment or property, a reduction in equipment operational efficiency, or jeopardize the successful completion of a mission. A routine priority involves normal manual improvement (clarification, editorial, simplification), potential personnel/equipment hazards with prolonged use, or a reduced operational equipment life.

All feedback deficiencies are assigned a NSDSA control number, evaluated and assigned for correction to either an acquisition manager (in-service, in-production equipment) or a cognizant technical code (in-service, out-of-production equipment). NSDSA tracks the status of deficiency correction action from the start until delivery to the user. The deficiency receives corrective action in three working days for emergency reports, and in 10 working days for urgent reports. For routine reports, the reporting organization receives an acknowledgement receipt within 10 working days and corrective action takes place within 90 calendar days of the report receipt. All no technical deficiency reports will be analyzed and resolved at NSDSA.

After the TM changes have been validated and verified by the procuring activity, camera-ready copy is sent to NPPSO (Naval Publications and Printing Services Office) for replication. NPPSO is responsible for the initial hard copy distribution to the user and the delivery of bulk copies to NPFC (Naval Publications and Form Center) for storage. All later requests for TM changes are made to NPFC via the Navy Supply System. NSDSA has the task of ensuring that NPFC maintains minimum levels of up-to-date TMs in stock. These minimums are defined in NAVSEAINST 5600.8.

ACNs are distributed only to the activities having the greatest need for the information, while other activities wait until the next permanent change or revision. Copies of the ACNs are not stocked in the Navy Supply System, but are controlled and maintained by NSDSA.

3.8.3 NAVSEA AND NAVELEX UPDATE FUNCTION (Continued)

NAVSEA has established a TM update priority system that uses the following formula which establishes a higher priority for the lower number.

TM update priority = (A x B x C x D) - E

A = Ship Importance Factor
  = 1 to 3 = SSNB to Lesser Support Ships

B = System/Equipment group/TM deficiency indicator factor
  = 1 to 15 = (Sys/Eqmt Grp - Primary/Auxiliary Service x Deficiency Urgency

C = System/Equipment Life Expectancy Factor
  = 1.0, 1.5, 2.0 = (5 to 10, 3 to 5, less than 3) years

D = System/Equipment Population Factor
  = 1 to 3 = over 250 to less than 25

E = Safety Override Factor. Depending upon safety aspects of the TM deficiency, assign a numerical value of sufficient magnitude to lower the resulting TM Update Priority to the priority desired. The need for the Safety Override Factor is not evident. The urgency of safety-related deficiencies dictates the use of an emergency or urgent priority and the issuance of an ACN for TM update. The removal of the Safety Override Factor would preclude the possibility of potential abuses to the priority formula.

NAVELEX SYSCOM - For in-production, in-service equipment, the acquisition manager is responsible for all TM updates, and tasks the equipment contractor to provide the updated TMs. For out-of-production, in-service equipment, a Cognizant Field Activity (CFA) is responsible for all TM updates. The CFA selects a contractor for all TM updates and accomplishes none in-house. If needed, acquisition managers can utilize NSDSA (Naval Sea Data Support Activity) in support of TM updating.

The contractor (equipment or data-house) furnishes camera-ready copy to NPPSO for printing, and the acquisition manager or CFA furnishes the required information to NPPSO for initial distribution to the user. NPFC retains all bulk storage copies and provides distribution for any future requirements via the Navy Supply System.

User feedback discrepancy reports are channeled to the responsible CFA for review, evaluation, and action.

3.8.4 NAVAIR UPDATE FUNCTION

NAVAIR uses a central facility to assist acquisition managers and cognizant Field Activities in budgeting and planning of TM updates. The facility also maintains a Master Technical Library of NAVAIR TMs and serves as configuration managers and distribution managers for NAVAIR TMs.

AIR 04A4, Logistics Technical Documentation Division is the NAVAIR technical manual (TM) program manager with responsibilities including development, coordination, and implementation of plans, policies, and specifications for a complete TM program. In addition, AIR 04A4 provides overall liaison and technical guidance and support to NATSF (Naval Air Technical Services Facility) and other field activities performing functions in support of NAVAIR logistics data and documentation.

NATSF has been assigned the mission to provide technical services in the development, preparation, publication, and distribution of aeronautic technical and maintenance management information to designated Naval and service-wide activities. It is the designated requiring activity responsible for the acquisition, control, quality assurance, maintenance, receipt, storage, retrieval, and distribution of NAVAIR TMs.

As a part of the above mission, NATSF is responsible for: (1) all budgeting for TM changes, (2) approval of all TM acquisitions, (3) distribution of TMs, (4) configuration management, and (5) TM contract requirements.

For in-production, in-service TMs, updates are usually the result of ECPs (Engineering Change Proposals) input by the contractor or a CFA (Cognizant Field Activity). The ECPs are the result of information reported by user feedback reports or of planned equipment modifications instituted by the equipment manufacturer (or a CFA). There are three ECP priorities: <u>emergency</u>, <u>urgent</u>, and <u>routine</u>. An <u>emergency</u> ECP is answered within 24 hours of receipt and pertains to a threat to national security or a hazardous condition that may result in either serious injury to personnel or extensive damage or destruction to equipment. An <u>urgent</u> ECP is replied to within 15 days and could, unless corrected, compromise a mission, cause injury to personnel, or cause damage to equipment. An ECP is also classified as <u>urgent</u> if it effects a $100,000 savings, or, if not implemented, causes a schedule slippage or a cost increase. <u>Routine</u> priority is answered in 45 days and encompasses all but <u>emergency</u> and <u>urgent</u> ECPs.

Upon approval of the ECP by the Change Control Board, the Project Manager (PM) advises NATSF of the new requirements. NATSF prepares the TMCR (Technical Manual Contractual Requirement) for inclusion in the RFP. The TMCR contains identifying specifications, delivery and pricing information to be enforced as a part of the contract. After PM issuance of the ECP, NATSF is responsible for maintaining the status of the ECP and the resulting changes to the TMs. Final cost figures are noted and recorded in the configuration package of the TM. Most ECPs for in-production equipment are performed by the equipment contractor, but can be accomplished by in-house engineering groups.

For out-of-production, in-service equipment, most updates are the result of discrepancies reported by using activities. The discrepancies come in the forms of Unsatisfactory Reports (URs), PMS (3-M) forms, and informal reports (telephone, correspondence, meetings). URs and PMS reports are routed from the user activities to NATSF for review, analysis, and disposition to the responsible Cognizant Field Activity (CFA). The CFAs evaluate each discrepancy reported and, if a TM update is deemed necessary, NATSF is notified of the requirement. NATSF reviews (approves/disapproves) the request, assigns a priority, and prepares a TMCR to cover the change. For non-ECP changes, O&MN (Operations & Maintenance, Navy) funds are used by NATSF to perform the changes. ECPs submitted by CFAs, contractors, or fleet users can also cause updates to the manuals. When ECPs are authorized, TM change funding is part of the equipment contract. NATSF still prepares the TMCR for the contract and acts as funding manager for the acquisition of the TM changes.

NAVAIR TMs are changed with Rapid Action Changes (RACs), formal changes, or revisions. RACs are issued only in emergencies (where safety or reliability are concerned) while formal changes and revisions are initiated periodically to update the TMs.

There are two types of RACs: interim and formal. Interim or Type I RACs are used when any of the following three conditions exist: (1) hazards to safety of personnel, (2) impairment to safety of flight, or (3) aircraft grounding. Formal or Type II RACs are prepared to replace an Interim RAC, or to provide an essential TM change. An Interim RAC is issued in message format, following approval and numbering by NATSF, to be followed by a Formal RAC within 60 days. The Formal RAC will consist of title page, text and illustrations as required, but not to exceed 12 pages total.

Manual Change Releases (MCR) are used when changes to TMs affect data only and do not impact any hardware. These changes are used as an interim medium until a formal change can be released to cancel the MCR. The MCR consists of interim inserts or supplemental pages to cover on-line, in-house maintenance support, or to notify other CFAs of TM changes.

Formal (normal) changes are prepared when a small number of pages are affected that cannot be changed by a RAC. This type of change is prepared to replace existing pages of the manual and incorporates all known errors plus any previously issued MCRs.

A Manual Revision replaces a TM and incorporates all previously issued changes to the existing manual. A Manual Revision is normally accomplished after a major change in equipment configuration (or a group of changes) which affects 50 to 60 percent of the existing TM and a Formal Change would tend to confuse rather than complement the existing TM.

For in-production, in-service equipments, the project manager almost always tasks the equipment contractor to provide any updates to TMs. Out-of-production, in-service equipments are controlled by CFAs, and any TM update is contracted to an in-house activity (with an AIRTASK requirement) or to a contractor (equipment or data house). In both the in-production and out-of-production phases, all TM change requirements are formulated by NATSF in the form of a TMCR (Technical Manual Contract Requirements). The camera-ready

3.8.4 NAVAIR UPDATE FUNCTION (Continued)

copy changes from either in-house or contractor facilities are sent to NPPSO (Naval Publications and Printing Services Office) for printing and distribution.

NATSF maintains a master copy of NAVAIR TMs and technical directives and administers the Technical Directive Program which includes numbering control and distribution. NATSF funds NPPSO for the printing and distribution and furnishes franked mailing labels plus a "pinking slip" showing the number of copies required for each addressee. NPPSO is responsible for the printing of the changes and for distributing the copies to the users according to the NATSF instructions. All bulk copies are sent to NPFC (Navy Publications and Forms Center) for storage.

After the initial distribution by NPPSO, all future requests for copies of the TM changes are obtained from NPFC via the Navy Supply System. NATSF reviews TM stock levels monthly and informs the CFA of any action to be taken for replenishing low stock levels.

3.8.5 PROPOSED TECHNIQUES FOR THE UPDATE FUNCTION

The Navy System Commands, as well as the non-Navy services, are moving toward internal development and production of all MOTD updates, rather than just out-of-production updates. This trend would severely impact the continuity of the contractor/military publications interface throughout the contractor support life of a system.

Navy MOTD Update Trends - The considered option of the Navy System Commands to develop an interface to the contractor's technical publications data bank during in-production programs impacts the contractor/Navy relationship. Some of the potentially impacted areas are costs, hardware and software interfaces, and continuity of contractor program organizations and personnel.

The proposed internal Navy development of in-production MOTD updates would eliminate the use of contractor personnel (who generated the original MOTD) for preparation of these updates. These personnel possess both system/equipment technical expertise and familiarization with MOTD program requirements obtained during original MOTD development. If the contractor delivered only the original TM, and performed no further effort, program personnel would necessarily be transferred to other assignments, thereby eliminating this resource (already paid for by the Navy) from the update effort. The redevelopment of this resource internally by the Navy would not be cost effective, and could result in update packages which are technically inaccurate and fail to correspond to the original MOTD from a presentation technique point of view.

A negative aspect of the proposed internal Navy production of in-production MOTD updates is the cost to provide a compatible interface between the Navy content capture system(s) and those of the various contractors. A difficult situation would exist in attempting to interface one or two central Navy processing systems with dozens of contractor technical information data banks. The most apparent problems are the wide varieties of computer coding (ASC II, EBCDIC, etc.), the different processing codes (operator instructions) and the different interface media. There are processing codes structured for each different system employed for content capture. A diversity of media, all customized to their systems, such as digital tape (7-track, 9-track, cartridges, cassettes, etc.), paper tapes, discs and diskettes present a substantial interface problem.

On the positive side, the proposed internal Navy development of in-production MOTD updates would result in reducing the time period from equipment modification to technical manual update. Some Navy change procurements are time-consuming, two-phased processes. The hardware modification is procured and later, as a separate effort, the technical manual updates are procured. In the proposed approach, the SYSCOM Program Manager can furnish the engineering change data to the SYSCOM publications activity (where the MOTD update would be developed) at the same time the hardware modification is procured.

Army and Air Force MOTD Update Trends - Both the Army and the Air Force are already performing selected in-production updates internally. Analysis of these programs reveals the existence of a serious configuration control

problem when contractors are asked to perform an MOTD update which is subsequent to an update which is performed internally by the military. There is usually no way for the contractor to easily determine what equipment modifications have already been incorporated into the latest MOTD configuration.

The Air Force Automated Technical Order System (ATOS) Program, planned for several phases over a 15-year period, is detailed in a Data Automation Requirement DAR LOG - MMO - D75-54 and in Section 3.4.2 of this report. Present plans are for ATOS to be an evolutionary program, building from the current AUTOTEC System which produces and updates internal publications including technical orders, work cards, indexes and lists of various types. Three alternative ATOS approaches are to be considered during Phase I of the program. The first alternative is to continue the current system (AUTOTEC and contractor support), the second employs the Automated Input and Document Update System (AIDUS) which is essentially the same as NAVAIR's TRUMP, and the third alternative is a custom-designed system. Approval and funding of ATOS has not been received to date.

TABLE 3-XXXII. IMPACT ON MILITARY/CONTRACTOR INTERFACE OF PROPOSED INTERNAL MILITARY DEVELOPMENT AND PRODUCTION OF ALL MOTD UPDATES

Area of Impact	Nature of Impact	Evaluation of Impact
Development	Eliminates use of contractor as resource of technical and MOTD expertise	Less cost effective and potentially poorer quality MOTD updates
Production	Initiates requirement for compatible interface between Navy content capture systems and contractors	Initial cost to Navy to provide compatible content capture system interfaces
Development	Eliminates possibility of two-phased procurement processes (hardware and MOTD)	Quicker deployment of MOTD updates in field
Development	Alternative use of contractor and military in-house capability	Less effective MOTD due to lack of MOTD configuration control

SUBSECTION 3.9
RESEARCH ISSUE 9: INTEGRATION

3.9.1 DEFINITION AND OBJECTIVES OF THE INTEGRATION FUNCTION

To ensure a systematic and cohesive development of this NTIPP research, and to enable a direct relationship between the research and the MOTD processing structure being designed, systems engineering tools analogous to those defined by MIL-STD 499A have been developed and applied.

Integration as an NTIPP research issue was introduced and defined in the August 1976 In-Process Review as one of nine research issues to be utilized to focus the efforts of this phase. Integration was defined at that time as the cohesive form which joined the other research issues to ensure a unity of effort. This report is the first occasion on which Integration is discussed in depth as a research issue and as a multifunction integrating force. The distinctive character of integration is delineated in Table XXXIII. In addition to the functional description associated with each research issue, a TM Organizational Counterpart column is also listed, with some current-day examples cited. The reader is urged to carefully consider the contents of this table, noticing the differing character of each research issue. In many cases, the research issues have direct TM organizational counterparts described on a functional basis. This is essentially a recogntion of the basic task functions that must be addressed in the MOTD processing structure. Notice that three issues, User-Data Match, Update, and Feedback are not necessarily reflected in an organizational entity. This approach allows primary focus on the processing of "new" MOTD which still maintains an awareness of these important aspects in which the MOTD structure must be responsive.

Integration as a means of controlling NTIPP research has fundamentally a two-part focus. First, to tie the research issues together, applying energy to interface difficulties between the research issues, and second, to serve as the "backstop." If a problem arises that falls between two research issues, or outside the current issue structure, the role of Integration as a research tool is to "catch" this and either redefine the constraints for separate issue control or to treat this condition as part of its own concerns. It should be noted that this research structure enables a direct reflection of the research results to the MOTD structure - no further transforms are needed. This condition is usually characterized by applied research, whereas most basic research must be viewed through a transform function to relate it to reality.

Since the issue of integration is concerned with assuring a totality of research as well as the total functional MOTD processing structure, the selection of tools is driven toward those which ensure a systematic treatment of both aspects. To use tools which promote a state of discord would simply increase the risk of error. Since Hughes has extensive expertise in the application of systems engineering principles and processes, the approach has been to construct the NTIPP research investigation along lines analogous to these disciplines. A review of Section 10.2 of Military Standard 499A - Systems Engineering Process, and its structure of

- Requirements Analysis
- Functional Analysis
- Functional and Subfunctional Allocation
- Synthesis
- ISL Considerations
- Cost Analysis
- Optimization
- Analysis Modeling

3.9.1 DEFINITION AND OBJECTIVES OF THE INTEGRATION FUNCTION (Continued)

and a comparison to the construction of the NTIPP Research Issue Structure, quickly defines the distinctive characteristic of the NTIPP research approach, as well as allowing a full appreciation of the role of integration.

TABLE 3-XXXIII. ORGANIZATIONAL RELATIONSHIPS TO RESEARCH ISSUES

Research Issue	Function	TM Organization Counterpart
1. User-Data Match	Focus on the need for providing TM Products structured to match the needs of the user community. (See Section 3.1 detailed explanation.)	Usually not an organizational entity. Primarily defined in specifications to date.
2. Data Acquisition	To provide the means and methods employed to obtain the "matched data" in the normal procurement process.	Usually has an organizational counterpart.
3. Content Generation	The activity which creates the MOTD from an engineering data base.	Always has an organizational counterpart. TM writing groups at a contractor facility or internal Navy (example: NSDSA Code 5600).
4. Content Capture	To provide the capability to "capture" the MOTD produced by the content generator in some form.	Always has an organizational counterpart. Usually a contractor "Text Processing and Graphics" organization.
5. Replication	To produce the requested number of copies of the approved MOTD that has been successful "captured" (or typed).	Always has an organizational counterpart. Usually a printing subcontractor. (Currently handled by NPPSO/GPO.)
6. Distribution	To place the copies of the approved MOTD in the hands of the user community.	Always has an organizational counterpart. Usually a government activity. (Currently NAVSUP-NPFC.)

TABLE 3-XXXIII. ORGANIZATIONAL RELATIONSHIPS TO RESEARCH ISSUES (Continued)

Research Issue	Function	TM Organization Counterpart
7. Update	To provide a focus for updating MOTD currently in the hands of the User community. This can be considered a mode of operation for the TM Structure. Intentionally separated from the acquisition on process of "new" MOTD.	Never has an organizational counterpart.
8. Feedback	To emphasize the essential point of user interaction with the MOTD Structure. Intentionally separated to ensure adequate treatment.	Could have an organizational counterpart. Usually found in the quality organization
9. Integration	The only multifunctional research issue to define and relate the individual forms of all other research issues and to represent the integration forces found in the MOTD Structure.	Some aspects of integration are represented by the TM Management Organization

3.9.2 INTEGRATION OF MOTD REQUIREMENTS IN THE WEAPONS SYSTEM

Decisions made in the initial phase of the Weapons System Acquisition Process dictate the role of MOTD which is to support a proposed system design. Identification of MOTD requirements early in this process is critical to the effective development production and support of user data.

The establishment of requirements for the development, production, and support of MOTD results from activities occurring in the Weapons System Acquisition Process (WSAP). As shown in Figure 3-54, each activity occurring at the system development level of the WSAP is supported by a related activity at the Integrated Logistic Support (ILS) level, which is in turn supported by a related activity in the MOTD acquisition level. For the purposes of discussion, the acquisition process has been shown as three separate, independent flows of activity. In reality, this flow is one complex, intermeshed, interacting, interdependent array of activities.

Concept Formulation is the first phase of the WSAP. The objective is to define and select system concepts which warrant further development. Output of this phase is alternative configurations for meeting system requirements. The significance of this phase to the development of MOTD cannot be overstated. The required operational capability of the proposed system is analyzed, MOTD concepts for meeting system requirements established, and alternative plans developed from those concepts to satisfy projected user data needs. It is here that the fundamental decisions of MOTD design are made: What is the complexity of the system? What kind of environment will it operate in? What is the maintenance philosophy? What is the skill level of the personnel operating the system? What kind of training and MOTD does the technician need to do his job? The answers to these and many other questions form the basis for planning and implementing all further MOTD acquisition activity. The evaluation of the "Required Operational Capability" of the proposed system must, therefore, take into consideration support capabilities, including MOTD. Without the proper inputs from personnel knowledgable of data requirements, support plans may be developed which do not provide for adequate MOTD. The significance of the activity occurring in this phase is further emphasized by recent research which indicates that by the time DSARC I takes place, approximately 70 percent of the system's acquisition resources funds have been allocated.[1]

The second phase of the process is Validation. It is here that alternative concepts developed in the previous phase are refined through analysis, hardware development, prototype testing, and tradeoff study. Plans for MOTD created in the Concept Formulation phase are developed into requirements, and criteria established for assessing contractor proposals efforts in

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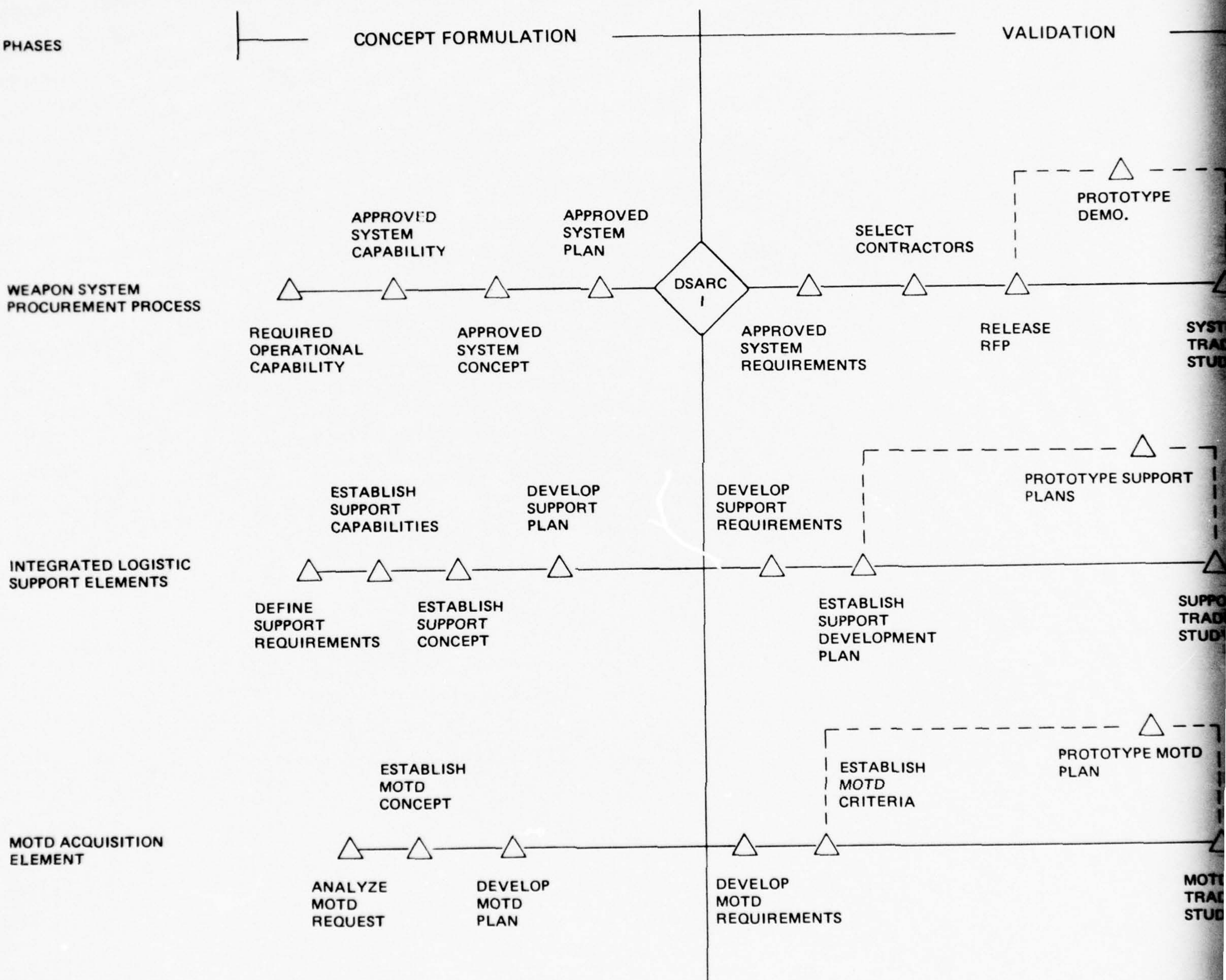
[1] Johnson, Eugene H., Manager, Design to Cost Laboratory, Boeing Aerospace Co., "Cost Estimating and Predicting" in Session III - Costing and Tracking of Cost Technology Workshop and Seminar, Hyatt House Hotel at L.A. International Airport, 3-5 November 1976.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VALIDATION
WEAPON SYSTEM
PROCUREMENT PROCESS
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INTEGRATED LOGISTIC
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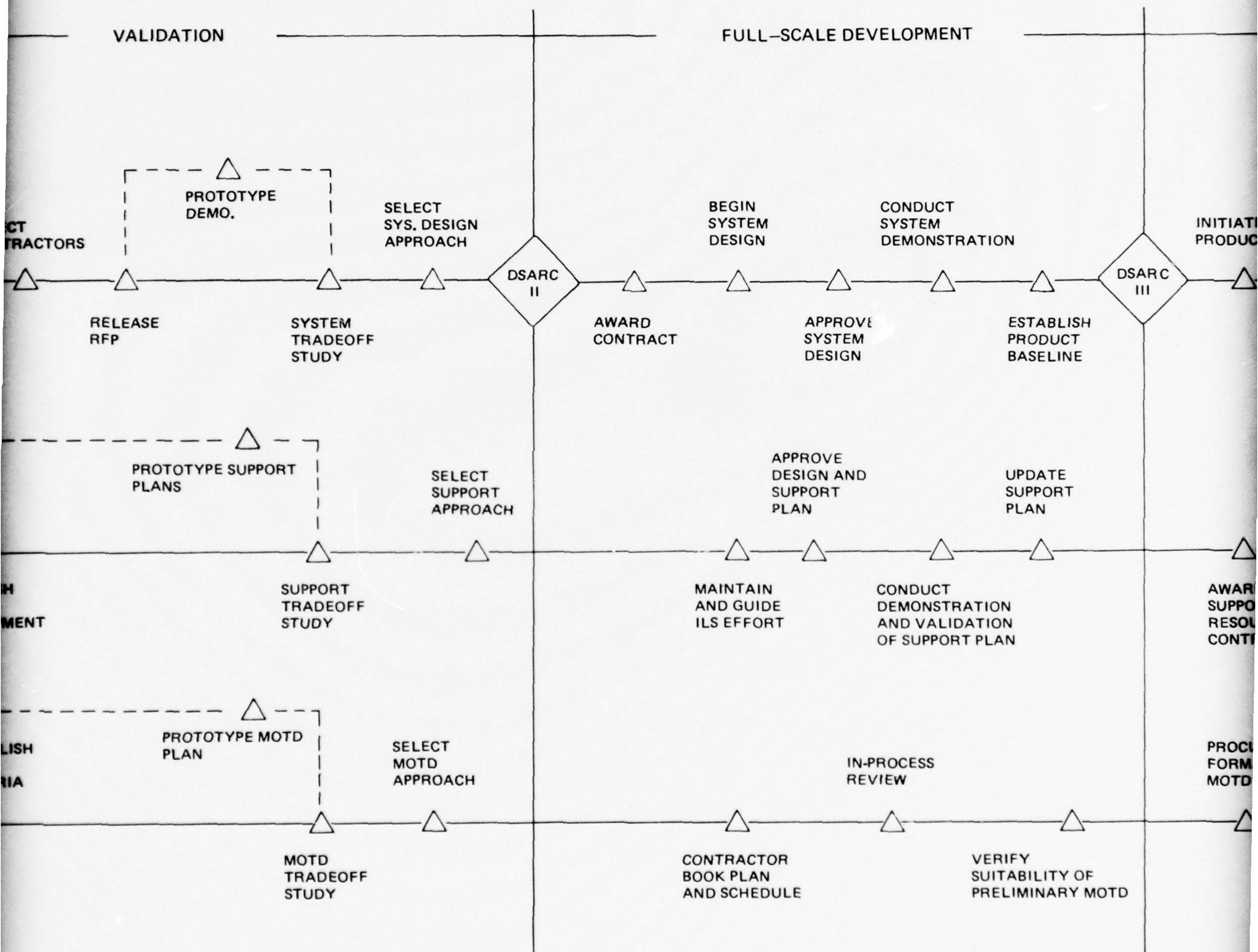

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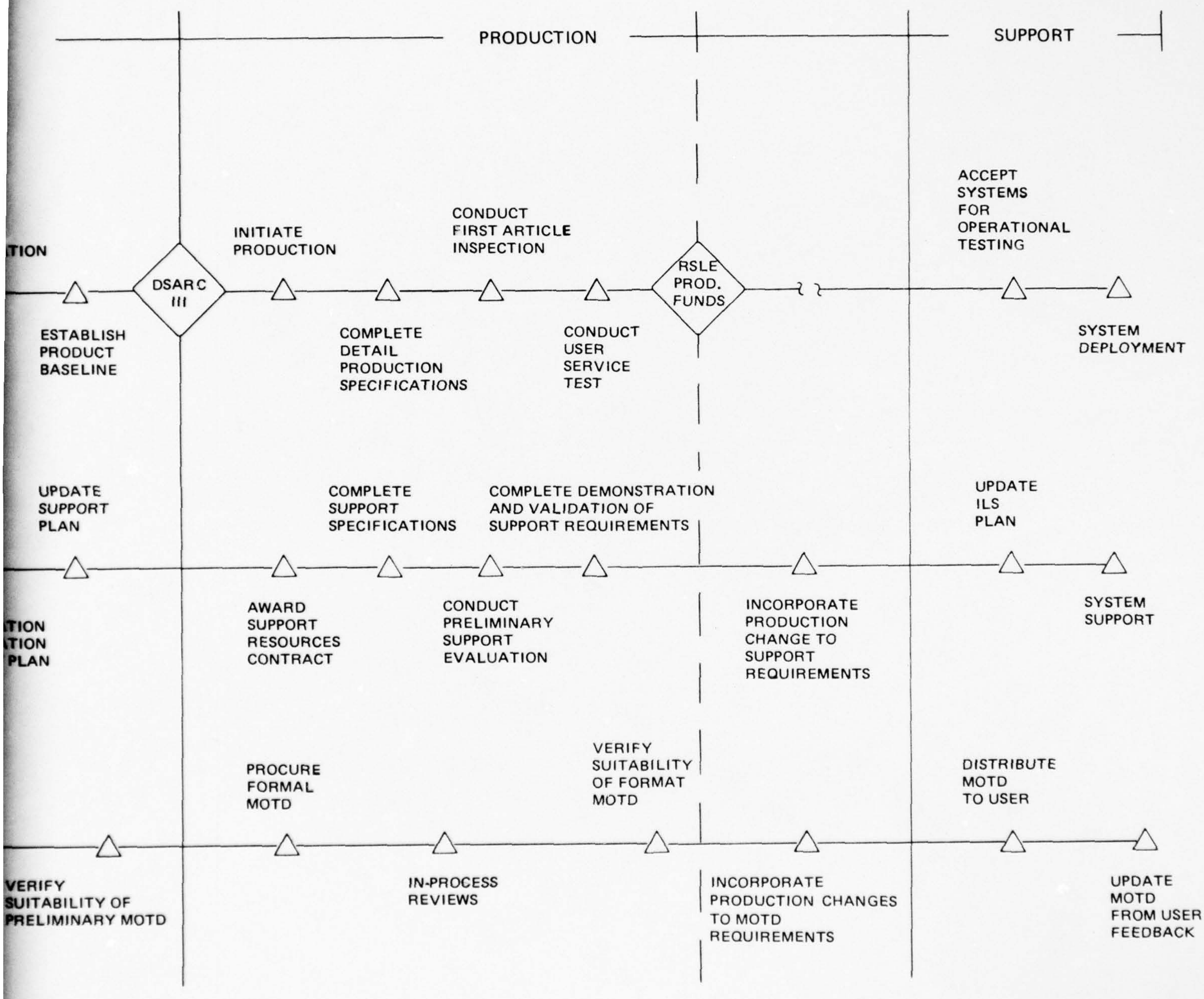

Figure 3-54. Relationship of MOTD Events to the Weapons System Acquisition Process. Because the system funds are allocated early in the process, adequate "up-front" consideration of MOTD matters is vital to the quality of subsequently delivered MOTD.

meeting those requirements. This phase may include prototype testing of MOTD contractor approaches against the aforementioned criteria. Whatever the method of proposal, prototype testing or simply a proposed approach, the end result is the selection of an approach to satisfy the operational support MOTD requirement. The main point to be made about this phase is that everything accomplished in it is done to satisfy the basic support concepts developed in the first phase. It should also be noted that by the end of this phase, DSARC II, when a contractor is selected, approximately 90 percent of system acquisition resource funds have been allocated.[2] The message here is that one is only going to get what he planned for "up-front."

In the Full-Scale Development phase the system, including all its support items is designed, fabricated and tested. The intended output is, as a minimum, a preproduction system which closely approximates the final product, the documentation necessary to enter the Production phase, and test results which meet system requirements. Activities occurring in this phase which are significant to MOTD acquisition include: creation of a book plan, in-process review of contractor MOTD activity, and verification of preliminary MOTD suitability. This phase puts to practice the concepts, plans and approaches developed in earlier phases and tests the results to see that they meet the MOTD design criteria. Its output forms the baseline for the Production phase. DSARC III serves as the review authority for progression to the next phase.

It is in the Production phase that the system, including its training equipment, spares, facilities, MOTD, etc, is produced for operational use. The primary objective of the phase is to efficiently produce and deliver to the operating unit, an effective, supportable system at optimum cost. All the "tools," ie, concepts, design criteria, approach, etc, developed in previous phases are put to work in the process of producing, deploying and supporting MOTD.

The primary intent of this topic has been to illustrate the importance of assuring that MOTD has been considered as a significant factor of the overall system design. This consideration cannot be put off until the later phases of the WSAP; it must be done early, at the time the required operational capability of a proposed system is evaluated in the Concept Formulation Phase. It is that evaluation, and subsequent formulation of concepts, requirements criteria and approaches, that establishes the role of MOTD in the operational system. The processes involved in assuring that these considerations are made is the job of integration.

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[2] Ibid.

3.9.3 INTEGRATION EMPHASIS DURING VARIOUS PHASES OF THE WEAPONS SYSTEM ACQUISITION PROCESS

Integration affects all the functions of the MOTD acquisition and development process, but the emphasis on each varies as the Weapons System Acquisition Process (WSAP) increments through each of its phases. Using MOTD concept development as an example, the major emphasis of integration is placed on the User-Data Match function during WSAP Concept Formulation phase; however, integration emphasis must also be placed, to a lesser degree, on each of the other functions so that their requirements are considered in the selection and development of the MOTD concept.

Concept Formulation Phase - During this phase of the WSAP, the MOTD requirements are established based on the operational capability and support requirements. Present MOTD capabilities are analyzed and new approaches studied to formulate an MOTD development concept. The last MOTD event in this phase is the establishment of the MOTD development plan where MOTD schedules are established and coordinated with system development.

Although the major integration emphasis is on User-Data Match during this phase (see Figure 3-55), some emphasis must be placed on the other MOTD functions. It is at this point that the basic requirements of the MOTD functions must be established and applied as part of the MOTD concept development considerations. In this phase, the decisions that have the greatest impact on MOTD as well as overall system/equipment and support life cycle costs and product effectiveness are made. An effective integration effort at this time in the program can reduce or eliminate most of the costly errors that might occur in subsequent phases of the WSAP while maintaining an optimum User-Data Match.

Validation Phase - In this phase, the MOTD concepts and plans are validated and refined through extensive study, analysis, development and prototype testing leading to detailed MOTD requirements. The MOTD portion of the RFP is prepared and incorporated as part of the overall system/equipment RFP. Criteria are established for evaluating contractor response to the MOTD portion of the RFP. Contractor responses are analyzed and tradeoff evaluations made against the criteria to select an approach that best meets the requirements of MOTD development and system/equipment support. Decisions resulting from these tradeoffs become part of the overall system design and support approach which is then subject to Defense System Acquisition Reviews Council (DSARC) II prior to proceeding to the next phase.

The integration function should assure that the MOTD requirements arrived at in this phase are responsive to the dynamic nature of the WSAP. The impact of any changes occurring in the system and/or support requirements on the MOTD concept is compared to the MOTD concept established in the previous WSAP phase. Integration then has to evaluate the results of this comparison against the requirements of the MOTD functions and provide recommended changes in the MOTD concept in order to maintain optimum User-Data Match within reasonable acquisition and subsequent support costs.

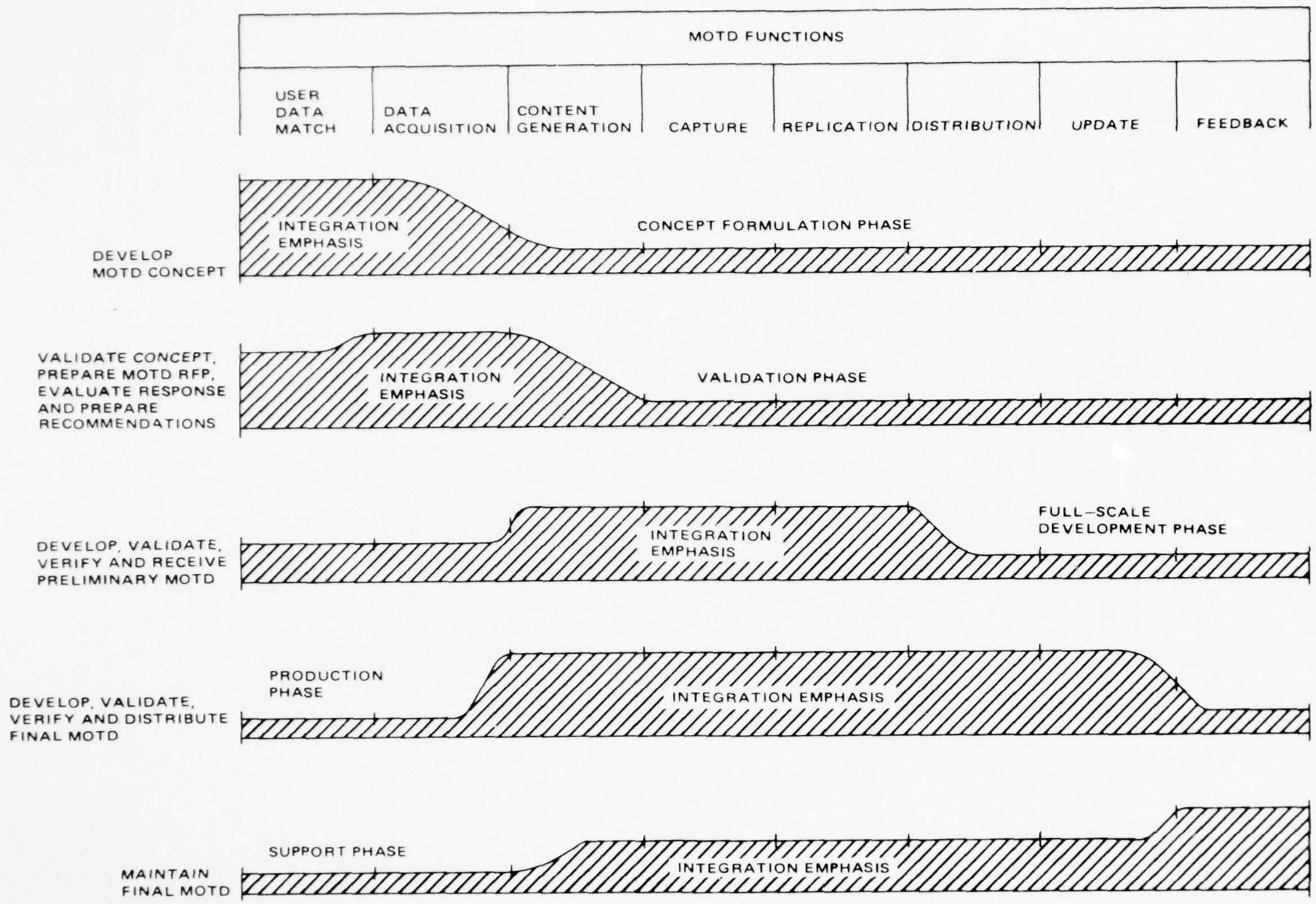

Figure 3-55. Integration Emphasis. Integration Impact on each MOTD function varies during the Acquisition and Development of MOTD in the weapons system acquisition process.

3.9.3 INTEGRATION EMPHASIS DURING VARIOUS PHASES OF THE WEAPONS SYSTEM ACQUISITION PROCESS (Continued)

Full-Scale Development Phase - The system/equipment and all its supporting elements, including MOTD, are contracted for, designed, fabricated and tested during this phase. As a minimum, the intended output is a preproduction system which closely approximates the final product, the documentation necessary to enter the next WSAP phase and test results which meet the system design and support requirements. During this phase, preliminary MOTD is developed, validated, and verified using the preproduction system, and delivered to the procuring activity.

Integration should play an important role during this phase of MOTD acquisition. Problems detected during in-process reviews, validation, and verification of the preliminary MOTD, as well as ones occurring between content generation, capture, and replication functions are analyzed and evaluated not only for impact during this phase, but impact on the total MOTD acquisition program. If during analysis and evaluation, sight of the total program requirements is lost, the resultant solutions would have a detrimental effect on the MOTD life-cycle and effectiveness objectives. This is where the value of the integration function becomes most apparent. For with effective integration, all facets of MOTD acquisition and support are considered in the evaluations. The resultant decisions will now continue to maintain optimum User-Data Match within reasonable MOTD life-cycle costs.

Production Phase - The production phase is the final phase in the acquisition portion of the WSAP. It is during this phase that the system/equipment, including its support elements (training equipment, spares, facilities, MOTD, etc) are produced for operational use. The primary objective is to deliver to the operational units an effective, supportable system at an optimum cost. At this time, final MOTD is developed from the preliminary MOTD, validated, verified, printed and distributed to the using activities. During this phase, the user feedback systems for system/equipment and support elements are also established.

Integration should play basically the same role in the production phase as in the full-scale development phase. But more emphasis is placed on the distribution and update functions to assure that accurate MOTD is delivered in proper quantities to the operational units and support activities in a timely manner.

Support Phase - WSAP activity reaches its lowest point during this phase. As using activities operate and maintain the system/equipment, various kinds of system/equipment and support problems including MOTD make their appearance. These problems and their user proposed solutions, if developed, are funneled back to the cognizant engineering and support element activities through the feedback system setup during the production phase. Changes resulting from the analysis and evaluation of the problems are instituted, implemented and delivered by the applicable support activities to the users. Procuring activity, support activity and contractor-developed changes and improvements are also evaluated and implemented to improve the system/equipment operational readiness capability within reasonable costs.

The integration effort, like the WSAP activity, should reach its lowest level during this phase. Although primary emphasis is on the maintenance of final MOTD through the feedback and update functions, the requirements of other MOTD functions which were established and performed during MOTD acquisition and development must be considered prior to every MOTD change. This is to assure that no changes are implemented which would impact MOTD usability or maintainability, or new practices initiated which would increase MOTD maintenance costs with little or no improvement in system/equipment operational readiness. For example, a new maintenance concept developed by personnel at one operational unit could not be implemented until all of its ramifications on the system/equipment and support elements are thoroughly investigated and evaluated.

The integration function emphasis on each MOTD function should vary during the WSAP phases in order to provide the foresight and hindsight necessary to enable MOTD to be acquired, developed, delivered, and supported at reasonable costs while improving its positive impact on the operational readiness capability of the system/equipment being acquired.

3.9.4 CRITERIA FOR EVALUATION OF CURRENT AND PROPOSED INTEGRATION METHODS

Integration of the MOTD management system, by use of systems engineering methodology, requires a set of criteria which form the basis for evaluation. An idealized, but workable, set of criteria is presented here which is directly correlated to the complete weapons system acquisition process.

The idealized set of MOTD management system evaluation criteria presented here is directly correlated to the major phases which occur during weapons systems procurement activities. The evaluation criteria are given in detail in Table 3-XXXIV. The five weapons systems acquisition phases are presented in chronological order, with the MOTD management systems functions given in detail, also chronologically, within the respective phases. The evaluation of any MOTD management system is based on how well it performs, or fails to perform, with respect to each of the functions listed during the respective acquisition phases.

Concept Formulation Phase - This is the most effective time to analyze MOTD requirements. Vital decisions are made in this phase which impact heavily on life cycle costs and on the overall effectiveness of the final product. This is the point where the least constraints are applied by external activities, and optimizing of User-Data Match can be the focal point.

Based on decisions made in analyzing MOTD requirements, the MOTD concept can be formulated. Here, the requirements are given a preliminary set of bounds which serve to bring the MOTD acquisition needs into perspective. This is the beginning of producing measurable results as the MOTD becomes quantifiable.

The final step in the Concept Formulation Phase is to apply a preliminary time-line to the MOTD requirements which appear to match the above bounds. The combined MOTD planning up to this point constitutes an MOTD management system which can provide viable supporting input to the ILS planning and Weapons Acquisition Management activity.

Validation Phase - The MOTD requirements proposed in Concept Formulation are further developed in this phase. The factors upon which the requirements were based undergo detailed analysis to determine the degree of validity of each. Adjustments and refining of the requirements are made, based on emerging program characteristics.

The MOTD requirements which emerge from validation are next assessed for the purpose of determining various criteria for evaluating performance, testing for compliance, and setting bounds. These parameters are then defined for use in evaluating this MOTD management system, and are prepared as an RFP input to the ILS and Weapons Acquisition Management activities.

Proposals from contractors responding to the RFP are evaluated for compliance to the MOTD management system requirements, by analyzing the proposed efforts with respect to the established criteria. The results of this evaluation are input to the ILS and Weapon Systems Acquisition activities.

Full Scale Development Phase - The successful contractor MOTD management system is reviewed for compliance to specified coverage and schedule against the established criteria. Assessments and review results at this point provide an excellent opportunity for obtaining a high-quality product, with minimal grief either on the contractor's or the Navy's part, if given adequate

time and attention. At this point a firm, well-defined, agreed-upon set of criteria will have minimum adverse impact on complete efforts and provide maximum benefit to all involved.

In-process review provides the checkpoint where the contractor and MOTD acquisition activity can reassure compliance to the prescribed MOTD management system, and can address problems which have appeared. Review and evaluation, using the established criteria, will uncover any problems in coverage or schedule which have gone unnoticed. The extensive analysis done in prior program phases will guide the participants towards optimized solutions or planned work-arounds.

This phase terminates with receipt of preliminary MOTD. The effectiveness of the contractor's performance in MOTD management for this weapons system is evaluated, based on comparison with the established criteria. The areas of update and user feedback are evaluated at this point also, with the added benefit of preliminary program performance enhancing the basis for any decision making.

Production Phase - The final MOTD production effort is initiated. Definition and specification of the various MOTD management system requirements can be made on a firm basis of analysis and actual performance at this point. There should be a minimum of surprises in MOTD-related efforts during the production phase.

In-process review of final MOTD provides the final review cycle of the contractor's execution of the MOTD management system, wherein problems can be addressed and solved without major impact. This affords a good opportunity to give added attention to the validation/verification efforts which are critical to the user's initial acceptance of the final MOTD.

Receipt of the final MOTD is the final, overall quality control checkpoint. The final MOTD is checked against the established criteria, and the criteria itself can be re-evaluated at this point with future programs in mind. Any shortcomings should be noted for future correction. The update and feedback cycles are initiated here to prevent loss of expertise on both the contractor's and MOTD acquisition activity's part. Update cycle activities will incorporate all effective equipment changes into the MOTD, using the established criteria to ensure quality data. The feedback cycle can be expected to be active at this time also, due to equipment and data "newness."

Support Phase - The support phase begins as soon as distribution is accomplished. The distribution effort should be evaluated to ensure adequacy and to investigate problem area.

The feedback system will be implemented fully during support. Attention will be paid here to ensure that the system remains viable and responsive. This is an excellent source of data for determining the adequacy and effectiveness of the final MOTD output. Knowledge gained from the feedback system can be incorporated into the analytical base for future MOTD acquisitions.

Monitor, Coordination and Control - The preceding discussion dealt with criteria for evaluation of MOTD acquisition activity within specific phases of the WSAP. As such, monitoring, control, and coordination techniques employed by the management of the total system were not addressed. Management, from a systems point of view, has one primary goal; satisfying the

3.9.4 CRITERIA FOR EVALUATION OF CURRENT AND PROPOSED INTEGRATION METHODS (Continued)

demand for MOTD by efficiently allocating scarce resources. The tools utilized for satisfaction of these goals are elemental to any management structure; planning, staffing, organizing, budgeting, cost control, performance evaluation, etc. The intent of this evaluation is not to make a value judgment of how well or to what degree these activities are being performed, but simply to aid this research in identifying needs for establishment of future NTIPP baseline design.

TABLE 3-XXXIV. MOTD ACQUISITION VERSUS WEAPON SYSTEM ACQUISITION PHASES

Concept Formulation Phase

1. Analyze MOTD Requirements
   - System complexity
   - User-Data Match
   - Spares support
   - Maintenance philosophy
2. Establish MOTD Concept
   - Develop preliminary publications tree
   - Define Head/Data/Training Tradeoff
   - Define Reading Grade Level
   - Designate replication media
   - Define output quantities
   - Define distribution requirements
   - Define update methodology
   - Define feedback origins and methodology
   - Define MOTD validation/verification parameters

TABLE 3-XXXIV. MOTD ACQUISITION VERSUS WEAPON SYSTEM ACQUISITION PHASES (Continued)

3. Develop MOTD Plan

   - Schedule reviews
   - Schedule preliminary MOTD completion
   - Schedule validation
   - Schedule verification
   - Schedule final MOTD delivery
   - Schedule update cycles

<u>Validation Phase</u>

1. Develop MOTD Requirements

   - Verify system complexity
   - Finalize preliminary publications tree
   - Designate specifications
   - Validate User-Data Match
   - Verify training plan
   - Verify spares support level
   - Validate maintenance philosophy
   - Establish schedule

2. Establish MOTD criteria

   - Assess risks and establish bounds
   - Assess costs, establish cost collection methodology and bounds
   - Establish test parameters of User-Data Match
   - Establish test parameters for training requirements

3.9.4 CRITERIA FOR EVALUATION OF CURRENT AND PROPOSED INTEGRATION METHODS (Continued)

TABLE 3-XXXIV. MOTD ACQUISTION VERSUS WEAPON SYSTEM ACQUISITION PHASES (Continued)

Validation Phase (Continued)

- Establish test parameters for spares support level match
- Establish test parameters for maintenance philosophy match
- Establish MOTD validation/verification requirements
- Prepare MOTD RFP input

3. MOTD Tradeoff Study

- Evaluate proposals for complete publications tree coverage
- Evaluate proposals for validation/verification coverage
- Evaluate proposals for MOTD compliance with User-Data Match requirements
- Evaluate proposals for MOTD compliance with training requirements
- Evaluate proposals for MOTD compliance with spares support level
- Evaluate proposals for MOTD compliance with maintenance philosophy
- Evaluate proposals for management risks
- Evaluate proposals for cost, management of costs, and collection of costs
- Prepare recommendations for Acquisition Management Office

Full Scale Development Phase

1. Review Contractor MOTD Plans and Schedules

- Assess plans versus schedule for inherent risks
- Assess plans and schedule for maintaining costs within bounds
- Review preliminary publications tree

TABLE 3-XXXIV. MOTD ACQUISITION VERSUS WEAPON SYSTEM ACQUISITION PHASES (Continued)

Full Scale Development Phase (Continued)

- Review plans for User-Data Match
- Review plans for maintenance philosophy match
- Review plans and schedule against final training requirements and schedule
- Review plans and schedule against spares support schedule
- Review plans and schedule for MOTD validation and verification activities
- Review plans and schedule for update consideration

2. In-Process Review

- Review risks incurred and anticipated
- Review costs incurred and anticipated
- Review percentage complete versus schedule versus publications tree
- Evaluate actual User-Data Match
- Evaluate compliance with maintenance philosophy
- Evaluate compliance with training requirements and schedule
- Evaluate compliance with spares support level
- Evaluate plans for MOTD validation and verification versus schedule
- Evaluate plans and schedule for update organization

3. Receive Preliminary MOTD

- Verify risks maintained within prescribed bounds
- Verify cost compliance

3.9.3 CRITERIA FOR EVALUATION OF CURRENT AND PROPOSED INTEGRATION METHODS (Continued)

TABLE 3-XXXIV. MOTD ACQUISITION VERSUS WEAPON SYSTEM ACQUISITION PHASES (Continued)

Full Scale Development Phase (Continued)

- Verify MOTD versus final publications tree versus the developed system
- Verify MOTD/User-Data Match
- Verify MOTD/maintenance philosophy match
- Verify MOTD training match and schedule compliance
- Verify MOTD/spares support match
- Verify MOTD validated/verified
- Evaluate plans and schedule for update
- Establish feedback system

Production Phase

1. Initiate Formal MOTD Preparation

- Define acceptable risk bounds
- Specify cost bounds
- Define final publications tree
- Define final User-Data Match requirements
- Define final maintenance philosophy match requirements
- Define final training data and schedule requirements
- Define final spares support level match requirements
- Specify validation/verification level-of-coverage and schedule
- Specify origination sources and schedule for update cycle
- Define feedback system

TABLE 3-XXXIV. MOTD ACQUISITION VERSUS WEAPON SYSTEM ACQUISITION PHASES (Continued)

<u>Production Phase</u> (Continued)

2. In-Process Review

- Review risk management
- Review cost management
- Review MOTD versus publications tree
- Review MOTD/User-Data Match
- Review MOTD/maintenance philosophy match
- Review MOTD/training data and schedule match
- Review MOTD/spares support level match
- Review MOTD validation/verification status
- Review update cycle status
- Review feedback system status

3. Receive Final MOTD

- Verify risk maintained within bounds
- Verify costs maintained within bounds
- Verify all final MOTD delivered (versus publications tree)
- Verify final MOTD versus User-Data Match
- Verify final MOTD complies with maintenance philosophy
- Verify final MOTD satisfies training requirements
- Verify final MOTD complies with spares support level
- Verify final MOTD validated/verified
- Establish update cycle plan and schedule
- Establish user feedback system

3.9.4 CRITERIA FOR EVALUATION OF CURRENT AND PROPOSED INTEGRATION METHODS (Continued)

TABLE 3-XXXIV. MOTD ACQUISITION VERSUS WEAPON SYSTEM ACQUISITION PHASES (Continued)

Production Phase (Continued)

4. Update cycle activities

- Incorporate production changes into MOTD
- Incorporate user-feedback derived changes
- Monitor update costs

Support Phase

1. Establish MOTD Distribution Requirements (Note that distribution of on-schedule MOTD is normally delivered with, or ahead of, equipment.)

- Distribute to training activities in accordance with training schedule
- Distribute to fleet-user activities in conjunction with equipment delivery schedule
- Distribute to remaining cognizant activities

2. Monitor Feedback

- Implement plan and schedule to monitor feedback system operation
- Evaluate feedback for User-Data Match effectiveness
- Evaluate feedback for adequacy of training support
- Evaluate feedback for effectiveness with respect to the maintenance philosophy
- Evaluate feedback for effectiveness with respect to real-world spares support levels
- Evaluate feedback to monitor the effectiveness of the quality control effort during validation/verification
- Evaluate feedback for MOTD coverage versus system complexity

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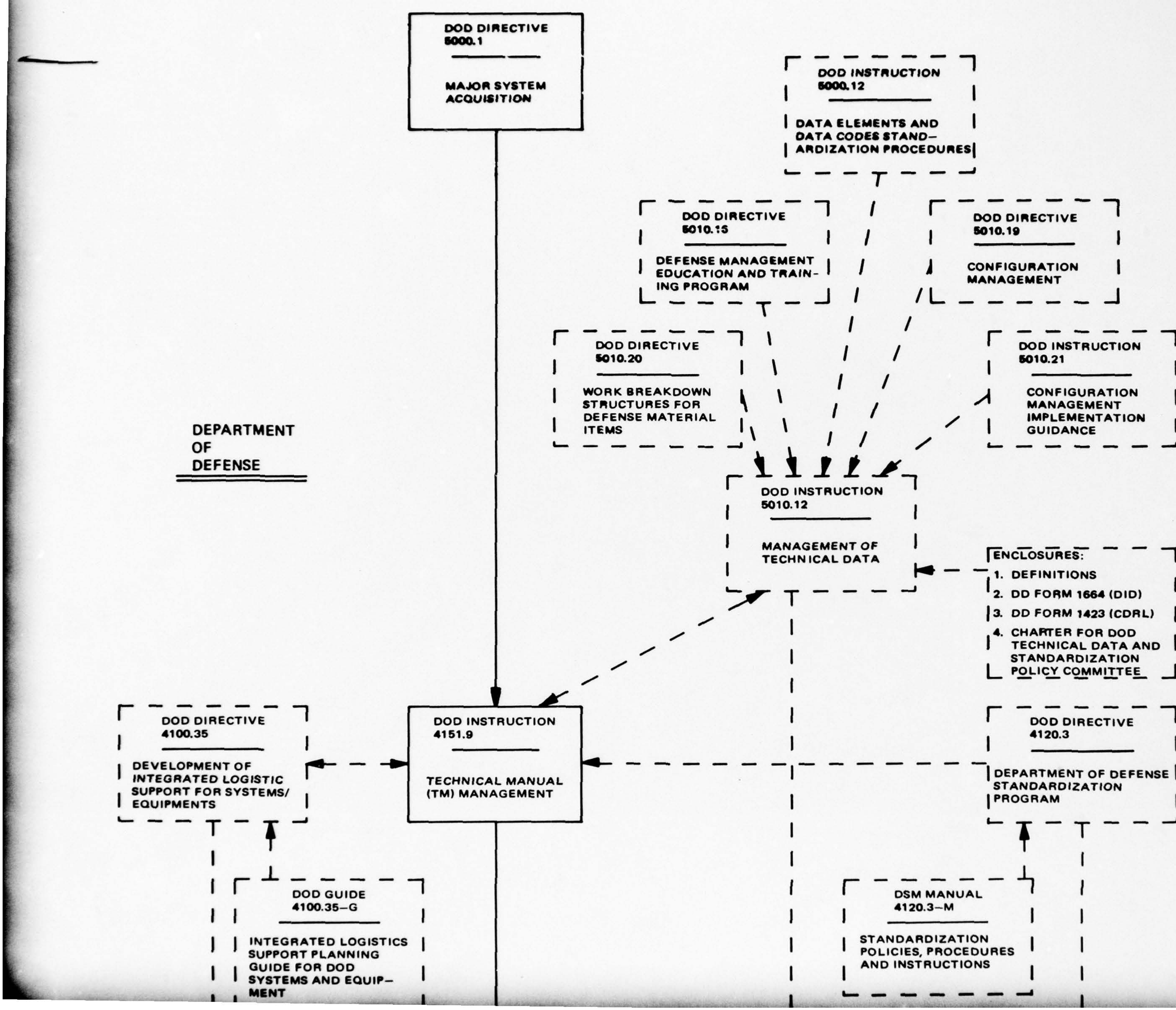
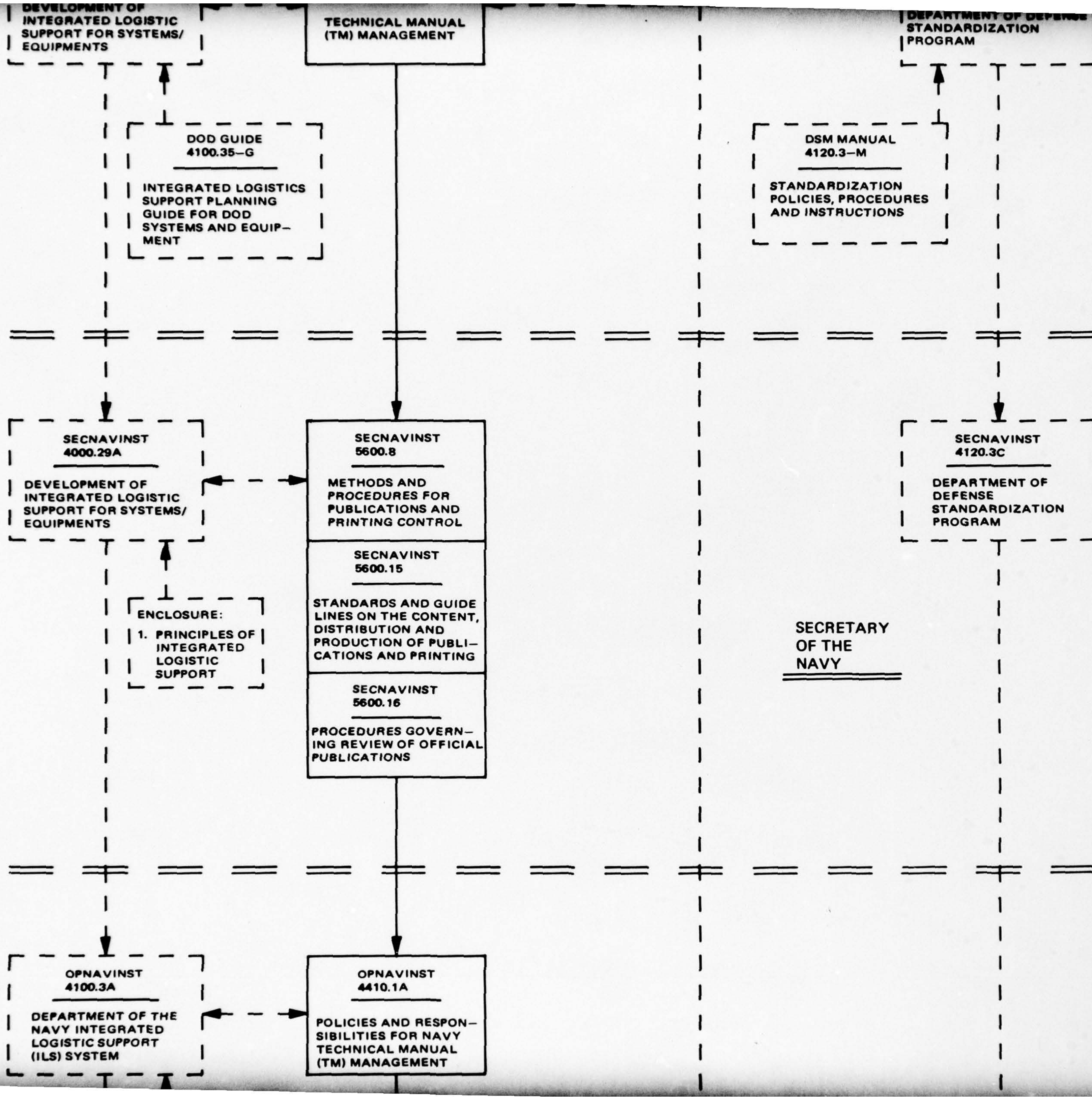
3.9.5 EVALUATION OF DIRECTIVES AND INSTRUCTIONS RELATED TO MOTD ACQUISITION

A review of the various policy and procedure documents related to MOTD acquisition reveals the lack of clear, explicit instructions as to how MOTD-related decisions are to be made within the Weapon System Acquisition and Integrated Logistic Support structures. This topic provides an overview of the major documents dealing with MOTD acquisition and their relationship to each other.

Directions and instructions describing the policies, responsibilities and procedures for the acquisition and management of MOTD are provided by DoD as part of the overall planning and management system for the procurement of system/equipments as set forth in DoD Directive 5000.1, "Major System Acquisition" (see Figure 3-56). Through the Department of the Navy, these directives and instructions are interpreted and implemented as necessary in order to meet the needs of acquiring MOTD consistent with the system/equipment acquisition program schedule. Although there are a basic set of instructions applicable only to MOTD acquisition and management, additional instructions provide the "how" and "when" to use these instructions as related to the total acquisition program. MOTD, being a part of the total system/equipment data package, is also impacted by instructions covering the whole data package in order to reduce or eliminate the purchase of quantities of data greater than is required for system/equipment development, manufacture and support. Instructions relating to the DoD standardization program establish a management program within the Navy Department for standardizing the form in which system/equipment data base specifications and standards including MOTD are prepared.

At the DoD level, in response to the policy established by DoD Directive 5000.1, the basic interservice policies and procedures for management of MOTD are established by DoD Instruction 4151.9, "Technical Manual (TM) Management." The objectives of this instruction are to (1) improve technical content of MOTD, (2) assure timely delivery to using activities, (3) reduce costs, (4) accelerate information feedback to effect necessary corrections, changes, and revisions, (5) develop agreements and procedures for management and exchange of MOTD of joint interest, and (6) establish new channels for interservice exchange of information on new or improved techniques for MOTD management. Since MOTD acquisition and management is an element in the Integrated Logistic Support (ILS) program, the policies and procedures of DoD Instruction 4151.9 are coordinated by DoD Directive 4100.35, "Development of Integrated Logistic Support for Systems/Equipment" along with its DoD Guide 4100.35G for planning the ILS. DoD Guide 4100.35G, in part, describes the MOTD acquisition and management steps and their relationship to the other ILS elements as well as systems management events for each phase (Concept Formulation, Validation, Full-Scale Development, Production and Deployment) of the Weapons Systems Acquisition Process (WSAP). DoD Instruction 5010.12, "Management of Technical Data," provides for the management of all technical data including MOTD and is intended to assure optimum effectiveness and economy in the support of systems/equipments within the defense establishment. This promotes effective use of data in coordination with ILS, Configuration Management, Systems Engineering and other similar systems. DoD Directive 4120.3, "Department of Defense Standardization Program," and its guide DSM Manual 4120.3-M as related to MOTD, establish policies and assign responsibilities


DEPARTMENT OF DEFENSE
DOD DIRECTIVE 5000.1
MAJOR SYSTEM ACQUISITION
DOD INSTRUCTION 5000.12
DATA ELEMENTS AND DATA CODES STANDARDIZATION PROCEDURES
DOD DIRECTIVE 5010.15
DEFENSE MANAGEMENT EDUCATION AND TRAINING PROGRAM
DOD DIRECTIVE 5010.19
CONFIGURATION MANAGEMENT
DOD DIRECTIVE 5010.20
WORK BREAKDOWN STRUCTURES FOR DEFENSE MATERIAL ITEMS
DOD INSTRUCTION 5010.21
CONFIGURATION MANAGEMENT IMPLEMENTATION GUIDANCE
DOD INSTRUCTION 5010.12
MANAGEMENT OF TECHNICAL DATA
ENCLOSURES:
1. DEFINITIONS
2. DD FORM 1664 (DID)
3. DD FORM 1423 (CDRL)
4. CHARTER FOR DOD TECHNICAL DATA AND STANDARDIZATION POLICY COMMITTEE
DOD DIRECTIVE 4100.35
DEVELOPMENT OF INTEGRATED LOGISTIC SUPPORT FOR SYSTEMS/EQUIPMENTS
DOD INSTRUCTION 4151.9
TECHNICAL MANUAL (TM) MANAGEMENT
DOD DIRECTIVE 4120.3
DEPARTMENT OF DEFENSE STANDARDIZATION PROGRAM
DOD GUIDE 4100.35–G
INTEGRATED LOGISTICS SUPPORT PLANNING GUIDE FOR DOD SYSTEMS AND EQUIPMENT
DSM MANUAL 4120.3–M
STANDARDIZATION POLICIES, PROCEDURES AND INSTRUCTIONS



DEVELOPMENT OF INTEGRATED LOGISTIC SUPPORT FOR SYSTEMS/ EQUIPMENTS
TECHNICAL MANUAL (TM) MANAGEMENT
DEPARTMENT OF DEFENSE STANDARDIZATION PROGRAM
DOD GUIDE 4100.35–G
INTEGRATED LOGISTICS SUPPORT PLANNING GUIDE FOR DOD SYSTEMS AND EQUIP– MENT
DSM MANUAL 4120.3–M
STANDARDIZATION POLICIES, PROCEDURES AND INSTRUCTIONS
SECNAVINST 4000.29A
DEVELOPMENT OF INTEGRATED LOGISTIC SUPPORT FOR SYSTEMS/ EQUIPMENTS
SECNAVINST 5600.8
METHODS AND PROCEDURES FOR PUBLICATIONS AND PRINTING CONTROL
SECNAVINST 4120.3C
DEPARTMENT OF DEFENSE STANDARDIZATION PROGRAM
SECNAVINST 5600.15
STANDARDS AND GUIDE LINES ON THE CONTENT, DISTRIBUTION AND PRODUCTION OF PUBLI– CATIONS AND PRINTING
ENCLOSURE:
1. PRINCIPLES OF INTEGRATED LOGISTIC SUPPORT
SECRETARY OF THE NAVY
SECNAVINST 5600.16
PROCEDURES GOVERN– ING REVIEW OF OFFICIAL PUBLICATIONS
OPNAVINST 4100.3A
DEPARTMENT OF THE NAVY INTEGRATED LOGISTIC SUPPORT (ILS) SYSTEM
OPNAVINST 4410.1A
POLICIES AND RESPON– SIBILITIES FOR NAVY TECHNICAL MANUAL (TM) MANAGEMENT

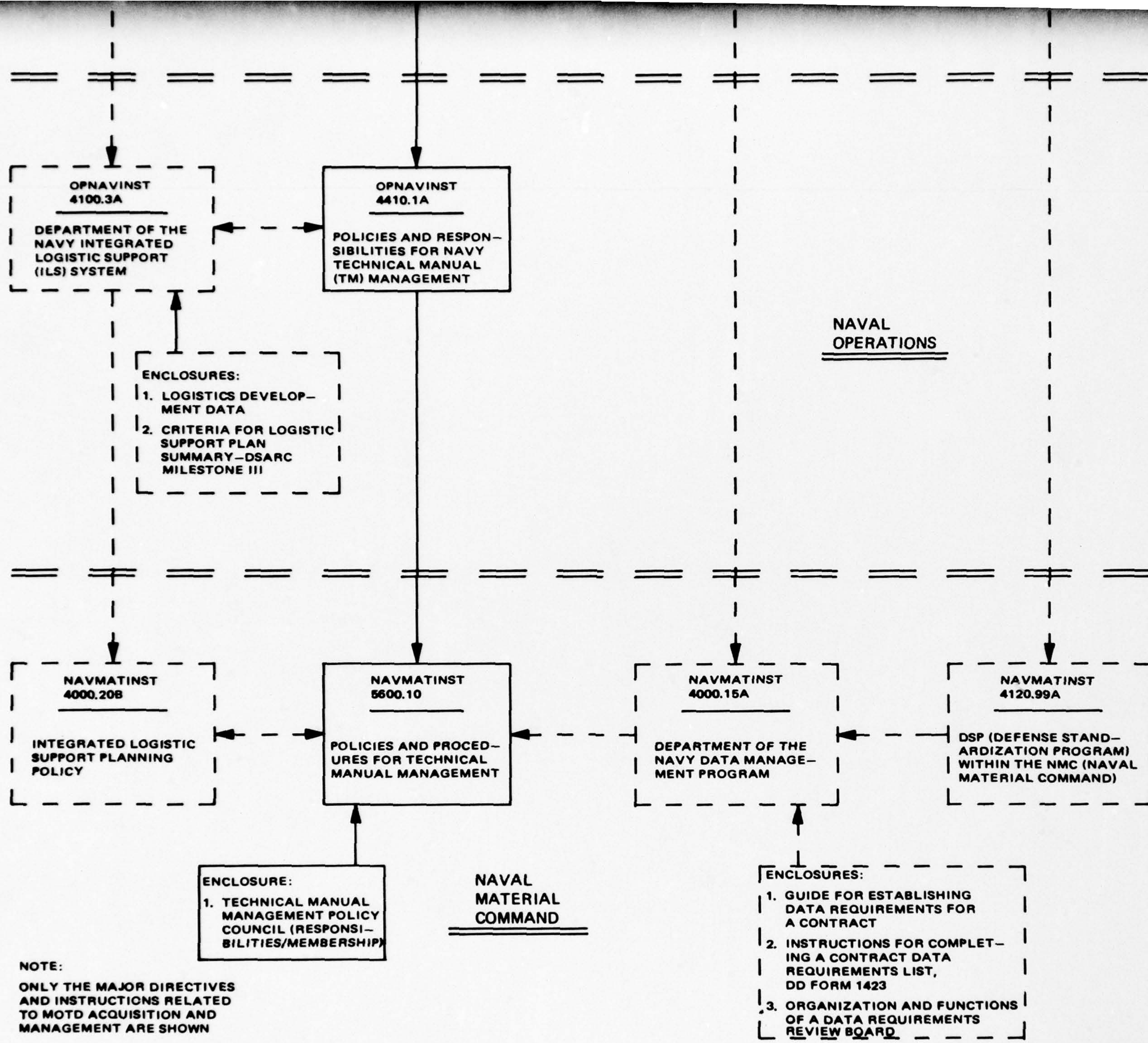


Figure 3-56. MOTD Acquisition Directives and Instructions

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3.9.5 EVALUATION OF DIRECTIVES AND INSTRUCTIONS RELATED TO MOTD ACQUISITION (Continued)

for the development and promulgation of specifications, standards, and handbooks that describe the items and services employed in the design, test and evaluation, procurement, production, maintenance, supply and disposal of MOTD acquired by the DoD components.

These DoD directives and instructions are implemented at the various management levels (SECNAV, OPNAV, and NAVMAT) of the Navy. As each directive and instruction is implemented at a specific level, amplification and interpretation are needed to meet the specific needs of that level. Of interest at this point are Enclosures 1 and 2 to OPNAVINST 4100.3A, "Department of the Navy Integrated Logistic Support (ILS) System." As indicated in Enclosure 1, all elements of ILS except MOTD are considered in the development of logistics support data during the concept formulation and validation phases of the WSAP. As indicated in Enclosure 2, MOTD development is considered in the technical data support plan which is an element of the ILS plan summary for Defense System Acquisition Review Council (DSARC) Milestone III which occurs prior to the transition from the WSAP Full-Scale Development phase to the Production phase. Significant and/or unique features of the technical data support plan including any problem or risk areas and the plans to minimize their impact are to be described at this point. Also comments are to be included on the phasing of data management, collection, updating and retrieval from the contractor to the organic responsibility. A more effective approach to the development of the technical data support plan to meet the DSARC Milestone III and in order to be in consonance with DoD Guide 4100.35G, which calls for consideration of all ILS elements during the WSAP Program Initiation, would be to include the MOTD element in Enclosure 1.

At the Naval Material Command level, NAVMATINST 5600.10, "Policies and Procedures for Technical Manual Management" establishes the objectives, policies and responsibilities for managing technical manual programs. Although this document is limited to MOTD, it instructs management personnel that they must recognize the essential relationships with other Navy programs such as ILS, Configuration Management and the Maintenance and Material Management (3-M) systems, and coordinate MOTD planning accordingly. Participation in the ILS program is covered by NAVMATINST 4000.20B, "Integrated Logistic Support Planning Policy." This instruction follows DoD Guide 4100.35G and describes the ILS plan as being initially begun as an outline covering all elements during the WSAP Program Initiation (Concept Formulation and Validation phases) and becomes fully developed by the beginning of the Full-Scale Development phase. Of course the level of ILS partiicpation and hence MOTD planning must vary according to the size and complexity of the system/equipment in order to keep the total support effort in proportion to the overall weapons system acquisition. Participation in ILS during the WSAP Program Initiation phase requires guidance for integrating MOTD requirements into the total technical data procurement package. Although this integration is an objective of NAVMATINST 4000.15A, "Department of the Navy Data Management Program," detailed guidance for performing this process is not evident. Additionally, all specifications and standards developed for MOTD acquisition and management are to be developed within the framework of the Defense Standardization Program as implemented by NAVMATINST 4120.99A, "DSP (Defense Standardization Program) within the NMC (Naval Material Command)."

3.9.6 EVALUATION OF NAVAIR MOTD INTEGRATION FUNCTIONS

Many of NAVAIR'S system/equipment support problems are attributable to a failure to adequately consider support requirements (including MOTD) during the concept formulation phase of the Weapons System Procurement Process. The assumption that NAVAIR's support capability is unbounded and can react effectively to support any system/equipment is unrealistic.

The Naval Material Command has established a series of instructions for the acquisition and maintenance of MOTD during the Weapons System Acquisition Process (WSAP). To meet the requirements of these instructions, NAVAIR has instituted and maintains various instructions and guides (see Figure 3-57) to deal directly with MOTD, while other instructions provide for the integrating of MOTD acquisition and maintenance into the overall Integrated Logistic Support (ILS) structure.

Concept Formulation Phase: Establish MOTD Concepts, Refine MOTD Concepts, and Develop MOTD Plan - In response to an operational requirement imposed by the Chief of Naval Operations (CNO), NAVAIR Systems Command developed a technical approach which results in a specific requirement for an experimental aircraft or missile. During this phase of the WSAP, minimal consideration is currently given to the formulation of a concept which should address significant aspects of MOTD development. The ILS policies and procedures contained in Aeronautical Requirement AR-30A state that technical data requirements (types and/or examples are not given) are to be established during the "program initiation phase." This term is used in AR-30A to represent the combined WSAP Concept Formulation and Validation phases. According to AR-30A, the actual MOTD requirements (TM Requirements in Figure 5-1 of Volume 2) are identified as the result of the Logistic Support Analysis (which is performed during the WSAP Full-Scale Development Phase (Figure 3-2 of Volume 2). MOTD-related considerations, such as the ability to maintain the weapons system within established bounds of operational availability and support capability, should but do not impact concept feasibility decisions. However, MOTD impact during the concept formulation phase is currently limited to the recognition that as indicated in NAVAIR 00-25-100, "When a new aircraft, engine, accessory, or other item of equipment is accepted by the Navy, manuals necessary to ensure its proper operation and upkeep are prepared and issued concurrently to all activities using and/or maintaining the equipment."

Validation Phase: Develop MOTD Requirements, Establish MOTD Criteria, and Perform MOTD Tradeoff Study - Once a concept is approved and a decision made to procure an aircraft or missile, all MOTD responsibilities are assumed by the Naval Air Technical Services Facility (NATSF). As indicated in NAVAIRINST 5600.20A and AR-30A, NATSF establishes MOTD requirements and develops the Technical Manual Contract Requirements (TMCRs) which become a chapter of the Integrated Logistic Support (ILS) plan. TMCRs identify all major airframe organizational level manuals such as NATOPS, IPB, Structural Repair, etc. The TMCRs are transmitted to NAVAIR Program Manager for incorporation into the Weapons System RFP. NATSF performs a technical review and scores the various contractor responses to the MOTD portion of the RFP, but does not review the cost proposals. A problem inherent in this process is

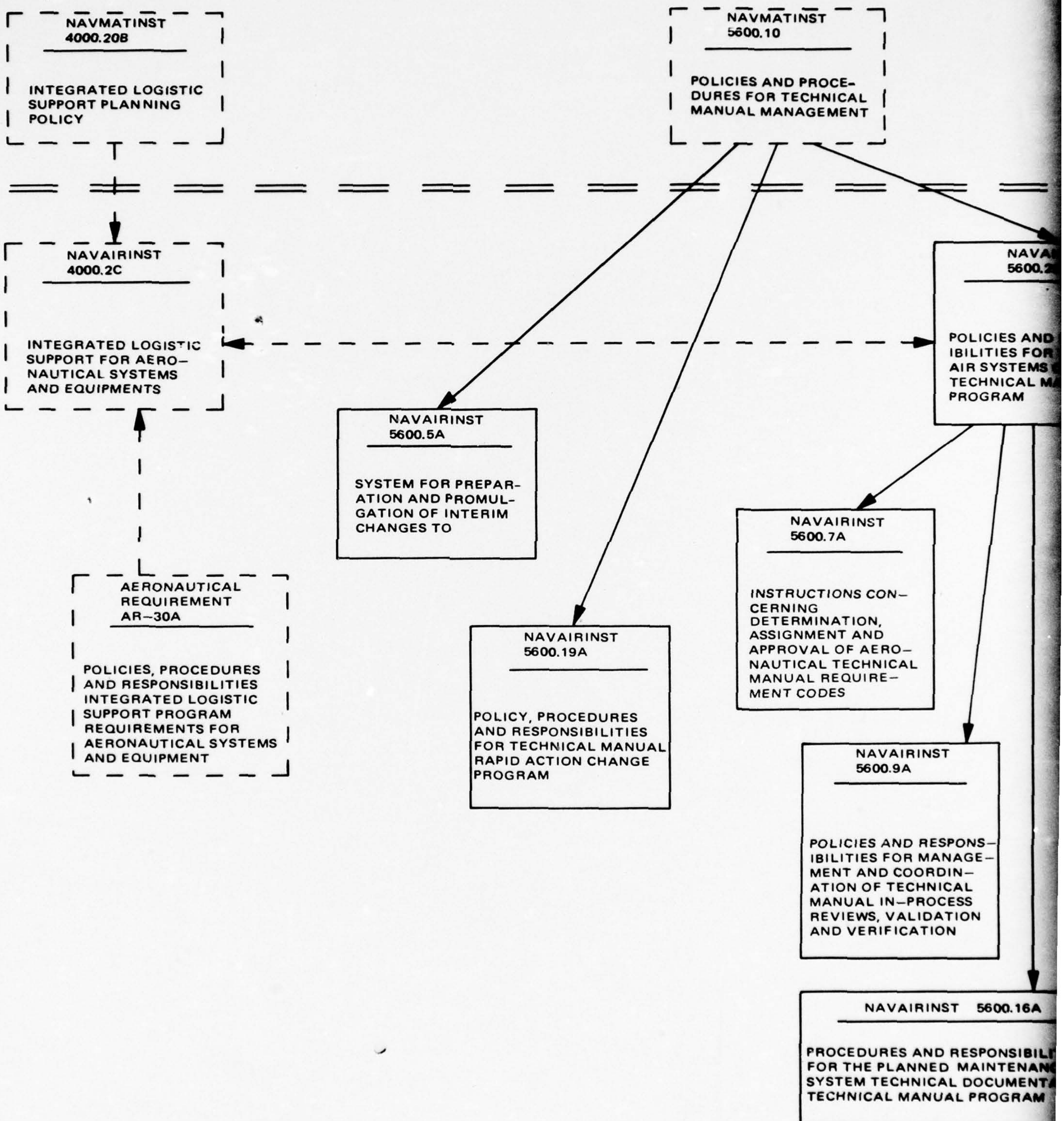

Figure 3-57. NAVA
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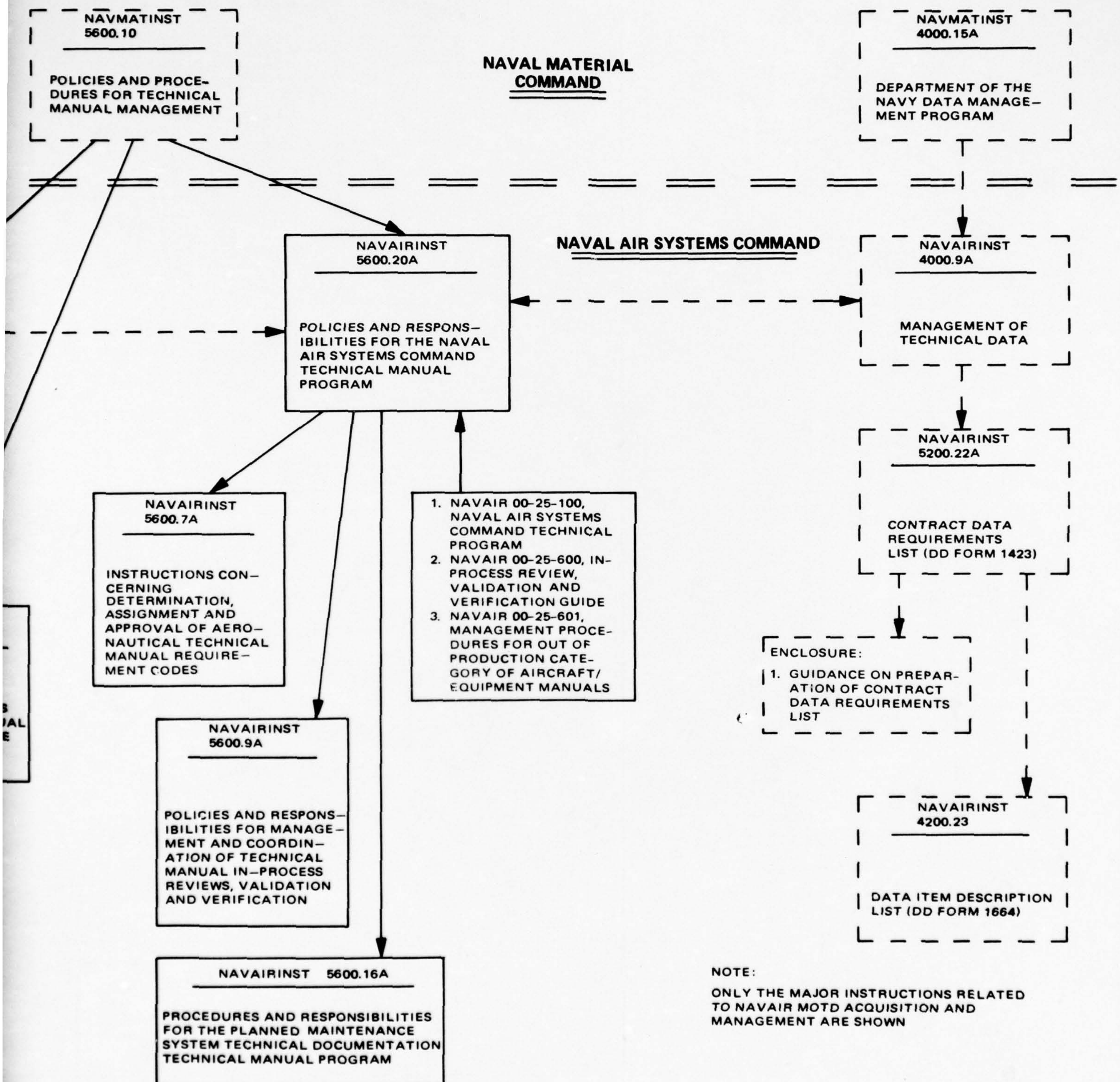

Figure 3-57. NAVAIR MOTD Management and Related Instructions for the Acquisition, Development, Delivery and Maintenance of NAVAIR Cognizant MOTD

that all support program decisions (including requirements for MOTD and training) must necessarily be reactive to determinations made during Weapons System Concept Formulation which assumed the existence of an essentially unbounded support capability. It should be noted that in some instances NAVAIR program managers have avoided the involvement of NATSF in the establishment of MOTD requirements.

Full-Scale Development Phase: Review Contractor MOTD and Plans and Schedules, Performed In-Process Review, and Receive Preliminary MOTD - Immediately after weapons system contract award, an ILS Management Team and a Logistic Data (MOTD) Management Team are established. The Logistics Data Management Team is staffed by NATSF personnel. On the programs which are not considered major, the Logistics Data Management Team is replaced by a single cognizant individual who functions as TM project coordinator or data manager. During this and the following phases of the WSAP, logistics conferences attended by the ILS Management Team, Logistics Data Management Team, and the contractor are held. At the first logistics conference after contract award, the contractor's TM Program Plan is reviewed. This plan indicates how MOTD requirements are to be met, but does not identify specific TMs other than those identified on the TMCRs (organizational level manuals). TM development efforts are monitored by in-process reviews, and preliminary MOTD is validated and verified in accordance with NAVAIRINST 5600.9A and NAVAIR 00-25-600 "In-Process Review, Validation and Verification Guide" to assure MOTD requirements are met.

Production Phase: Initiate Formal MOTD Preparation, Perform In-Process Review, Receive Final MOTD, and Perform Update Cycle Activities - During the production phase of the WSAP, the aircraft contractor is tasked with identifying the requirements for intermediate and depot level MOTD. The vehicles used for transmitting these requirements to NAVAIR are Technical Manual Data Cards which are submitted by the contractor on a continuing basis. These cards identify intermediate and depot level TMs including information such as equipment, specifications, cost estimate, and delivery schedule.

Support Phase: Establish Distribution Requirements and Monitor Feedback - During the support phase of the WSAP, NAVAIR modifies MOTD to reflect hardware changes or to correct deficiencies that are not related to hardware changes. NAVAIR uses its cognizant field activities (NARFS) to generate MOTD revisions for out-of-production equipment. MOTD revisions for in-production equipment are procured from the aircraft contractor. NAVAIR has two basic types of MOTD change procedures - those which can be described as formal, and Rapid Action Changes (RACs) which are not considered formal. Policies, procedures and responsibilities for the management, preparation and issuance of RACs are provided in NAVAIRINST 5600.19A. Formal changes are initiated periodically, while RACs are issued only in emergencies, where safety or equipment reliability are concerned. In addition to formal changes and RACs, there is also a system, established by NAVAIRINST 5600.5A for issuing interim change pages to Naval Air Training and Operating Procedures Standardization (NATOPS) flight manuals.

3.9.7 EVALUATION OF NAVSEA MOTD INTEGRATION FUNCTIONS

Significant MOTD considerations do not exist in NAVSEA which parallel the TM design and development effort to the Weapons System Acquisition Process (WSAP) phases. Many of these considerations are either lacking or partially attempted, and in many instances, by the wrong people. In general, activities responsible for NAVSEA TMs put too much reliance on hardware acquisition to steer the course of the TM. Too many critical TM decisions which need to be made in initial stages of development to ensure an effective and usable TM product are made outside the realm of NAVSEA TM expertise. The relationship between NAVSEA TM activities and the five main phases in the weapons system acquisition cycle is detailed below.

NAVSEA has established a series of instructions to implement the Naval Material Command's directions in the acquisition and maintenance of MOTD (see Figure 3-58) during the phases of the WSAP. These instructions provide guidance for MOTD acquisition and maintenance and the integration of this guidance within the system/equipment and support acquisition process.

Concept Formulation Phase: Establish MOTD Concepts, Refine MOTD Concepts, and Develop MOTD Plan - Based on an Operational Requirement (OR) issued by the CNO, NAVSEASYSCOM activities are made aware of Development Proposals (DPs), which are the results of feasibility studies, and are initiated to define the concepts for a ship/weapons system/equipment. Once approved, a Ship Acquisition Program Manager (SHAPM) is designated and chartered to satisfy Top Level Requirements (TLR) and Top Level Specifications (TLS) issued by the CNO. A Ship Acquisition Plan (SHAP) is then generated to outline the general concept descriptions.

Technical Manual (TM) considerations at this point are stated in general terms; i.e., that system/equipment will be supported by TMs.

As cost and feasibility studies by the SHAPM proceed, the SHAP broadens and becomes more detailed but at this point is still a management plan. During this time an Advanced Procurement Plan (APP) is usually developed, which explores alternate methods of procurement. TM activities, NSDSA, are required to submit budget estimates which are obtained from historical data contained in the STEDMIS/STEPS system. Other requirements of TM activities during this time as defined by NAVSEAINST 5600.7 are preliminary ideas on how the system/equipment is to be supported. A brief Integrated Logistic Support Plan (ILSP) developed in accordance with NAVSEAINST 4000.5 and Ordnance Regulation OR-30 is usually generated at this point which covers conceived means and methods for maintaining supply, training, etc. Again, background data from past procurements is usually the source of these conceived support plans. As planning proceeds, the ILSP becomes a part of the SHAP, and this and other data from various sources are compiled and presented to the CNO.

Based on the CNO's decisions, a concept design called the Conceptual Baseline (CBL) is established and documented by the TLR. This effort culminates with the representation of the project for review before the Defense Systems Review Council (DSARC I).

The total involvement or process by which NAVSEA TM activities adequately address the listed items of MOTD considerations is lacking or nonexistent during this phase.

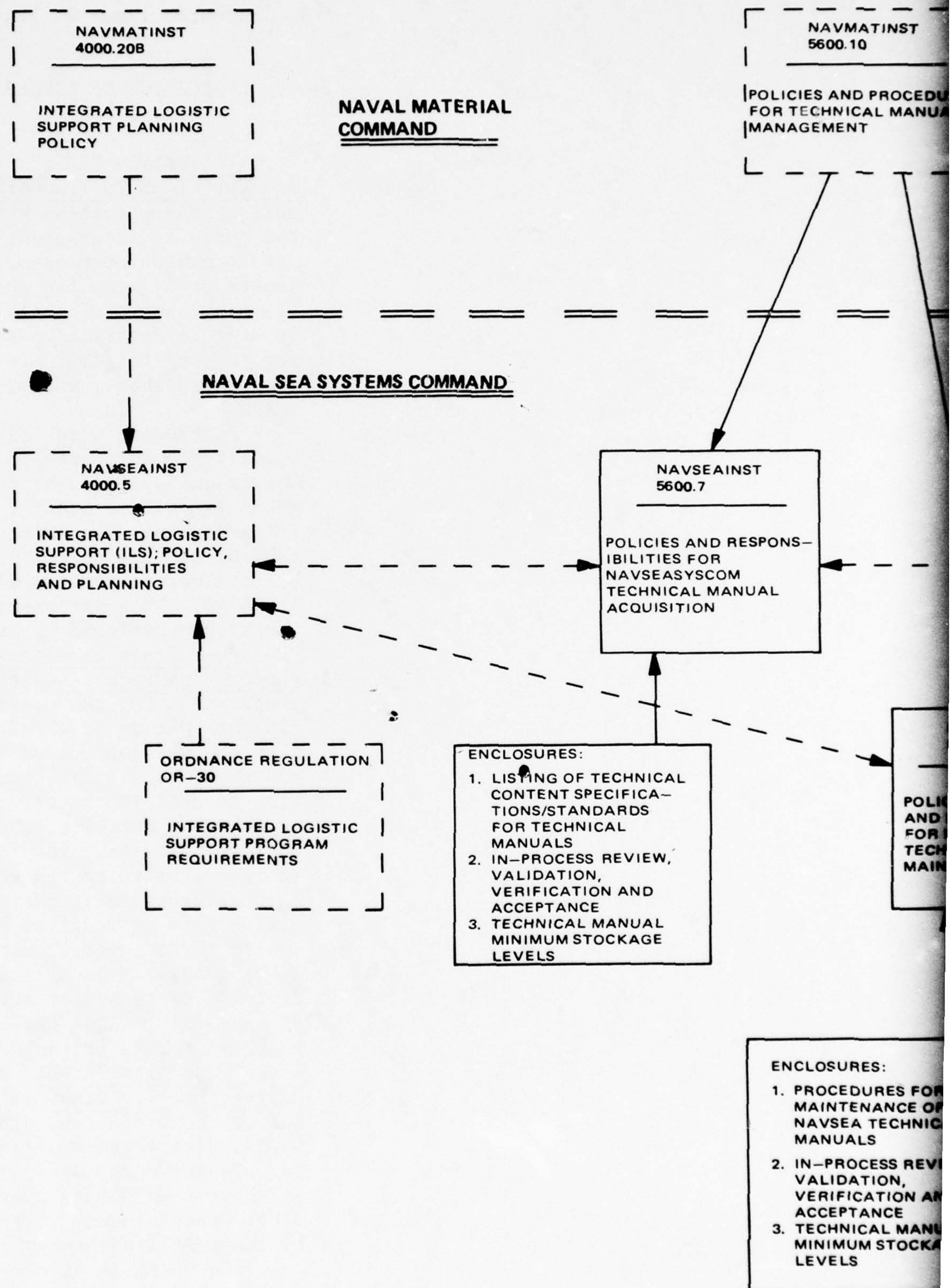

Figure 3-58. NAVSEA MOTD Man
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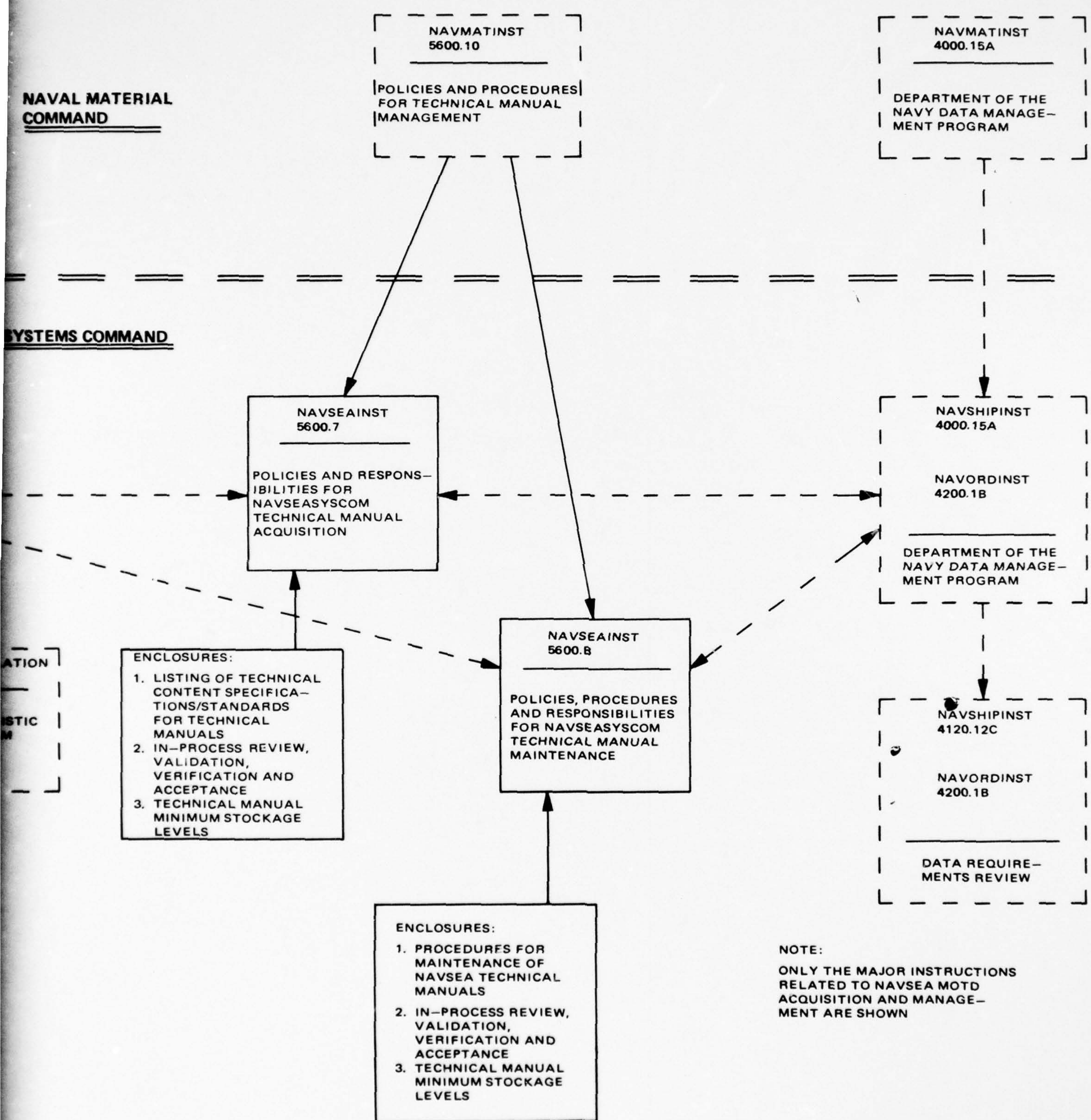

Figure 3-58. NAVSEA MOTD Management and Related Instructions for the Acquisition, Development, Delivery and Maintenance of NAVSEA Cognizant MOTD

3.9.7 EVALUATION OF NAVSEA MOTD INTEGRATION FUNCTIONS (Continued)

Validation Phase: Develop MOTD Requirements, Establish MOTD Criteria, and Perform MOTD Tradeoff Study - After DSARC I approval, the system/equipment design phase proceeds with a firmer TLR, based on the specifics under which the approval is granted. At this time SHAPM funds the update of the TLS and its companion documents. NAVSEA-designated activities, such as NSDSA, may be tasked to upgrade the portion of the TLS dealing with ILS requirements for TMs. Planning initiated at this point requires that TM requirements be identified in as much detail as possible. Prior to DSARC II, NAVSEA TM activity role in the process is still minimal, does not treat with the majority of MOTD validation phase items, and is again largely acting in an advisory capacity to the SHAPM.

Proceeding with the validation phase, a Functional Baseline (FBL) is established and contract design planning is authorized to begin by the SHAPM. Master equipment lists for the planned acquisition are prepared by NAVSEC. NSDSA is responsible for reviewing and updating Section 86 of the General Specifications for ships of the U.S. Navy to assure TM objectives are met (which, at this point, have not been adequately defined). NSDSA may also be required to provide assistance to NAVSEC in the development of the GFI listings. This information is compiled by the SHAPM, and the planning documents are reviewed by NSDSA to assure their compliance with TM objectives.

Full-Scale Development Phase: Review Contractor MOTD Plans and Schedules, Perform In-Process Review, and Receive Preliminary MOTD - The SHAPM begins the preparation for the procurement of required TMs. Those which cannot be identified are put on deferred ordering lists. Preparation for TM acquisition begins with the development of the TMCR/TMSR which is prepared by a technical activity and reviewed and assigned a number by NSDSA. The preparation for the acquisition of HM&E TMs is also the responsibility of the SHAPM. The SHAPM will task a technical activity to prepare the TM procurement package which NSDSA will review, if tasked, for form and content. NAVSEA TM activities may or may not be requested to review contractor responses to solicitations.

After contract award, the SHAPM will initiate changes to the TM acquisition plan as modified by contract negotiations. NSDSA may be tasked to modify these contract documents (TMCR, CDRL, DIDs, SOW). Contractor plans, TMOPs generated as a result of deferred ordering, and schedules, will be reviewed by technical activities who will advise the SHAPM on approval or disapproval. NSDSA may also be required to analyze contractor-furnished DD-633-2 forms, if tasked.

Production Phase: Initiate Formal MOTD Preparation, Perform In-Process Review, Receive Final MOTD, and Perform Update Cycle Activities - Contractor quality control plans are reviewed by the cognizant technical activity and NSDSA, with recommendations of acceptability to the SHAPM. Once the contractor plans are approved, the technical activity initiates a verification plan which the SHAPM must approve. The contractor must develop and submit a Technical Manual Index (TMI) which is reviewed by the technical activity, approved by the SHAPM, with copy to NSDSA for the STEDMIS/STEPS files.

The SHAPM is also responsible for ensuring that an in-process review (IPR) schedule as defined and described in NAVSEAINST 5600.7 is set up, or NSDSA may be tasked and funded to schedule, conduct, or otherwise participate

in the IPR. Review of the preliminary manual for level and coverage is conducted by the technical activity/SHAPM. Copies of the preliminary manual are distributed to other DD Form 1423 codes for information. Approval of preliminary copy and distribution list is made by the SHAPM with copy to NSDSA for the STEDMIS/STEPS files. NSDSA provides the NAVSEA TM number, which is furnished to the contractor through SUPSHIPS, along with returned copies of the preliminary manuals which must be changed/updated in accordance with the technical activity/SHAPM.

During the TM production process, TM hardware activities are still calling the shots as allowed by NAVSEAINST 5600.7 and NAVSEA TM specialists continue to function as bookkeepers and advisors, if funded.

Support Phase: Establish MOTD Distribution Requirements and Monitor Feedback - NAVSUP Form 1088 is initiated and forwarded to NPFC by either the technical activity or the SHAPM. The SHAPM must authorize NPFC to distribute to anyone other than those contained on the distribution list.

If tasked and funded, NSDSA will monitor verification and act as a participant. Verification discrepancies must be corrected before the SHAPM gives contractor authority to deliver final camera-ready copy (with enclosed distribution list) to NPPSO, via SUPSHIPS, for printing. Commercial manuals are procured by the contractor and distributed in accordance with instructions from the SHAPM.

The SHAPM will task and fund NPPSO to inspect, print, and distribute the printed manuals. Camera-ready copy is then sent to the planning yard designated by the SHAPM and printing negatives to NPPSO, Philadelphia. A copy of the final TM distribution list is also sent to NSDSA for the STEDMIS/STEPS file.

Tasking and funding for microfiche manual requirements are made to NSDSA which prepares a set-up sheet and tasks a local NPPSO to produce and distribute. The working master is retained by NSDSA.

For maintenance of TMs, NAVSEAINST 5600.8 establishes policy, provides guidance in terms of requirements and standards, and defines responsibilities and accountability for maintenance of NAVSEA cognizant technical manuals including advanced changes, permanent changes and revisions. Here again, acquisition managers, logistic managers or other cognizant managers procuring modified equipment and/or systems, overhauling or modifying ships are responsible for managing the planning, funding, procurement, preparation, production and acceptance of technical manuals for their programs. They are also responsible for tasking and funding, as necessary, technical activities and/or NSDSA to provide TM management and support functions and NPPSO for TM publishing support. NAVSEA TM specialists again function as bookkeepers and advisors, if funded.

Though many potential sources for utilization of effective user-feedback/changes/updates exist (STEDMIS/STEPS, SECAS, FOMIS, 3-M, NAVSUP 2002) within the Navy, practical application in NAVSEA to coordinate, implement, and put into operation a responsive system does not exist.

3.9.8 EVALUATION OF NAVELEX MOTD INTEGRATION FUNCTIONS

The NAVELEX MOTD procurement process is unique in that an outside service contractor is used to assist in the generation of MOTD acquisition documents, monitoring of MOTD development contractor activities, and review and approval of final MOTD products. However, as with other Navy and non-Navy military agencies, support requirements (including MOTD) are not adequately considered during hardware concept formulation.

Basic policies governing the acquisition, management and quality assurance of NAVELEX MOTD are prescribed by NAVELEX Instruction 5600.7, which implements the Naval Material Command's instructions concerning MOTD (see Figure 3-59). MOTD acquisition and management is integrated as an element of the support function in the Integrated Logistic Support (ILS) program by NAVELEX Instruction 4000.6B in order to respond to the requirement of the Weapons System Acquisition Process (WSAP) in a timely manner. But in actual practice, MOTD acquisition and management is accomplished during the WSAP as described in the following paragraphs.

Concept Formulation Phase: Establish MOTD Concepts, Refine MOTD Concepts, and Develop MOTD Plan - In response to operational requirements imposed by Chief of Naval Operations (CNO), NAVELEX System Command develops a technical approach which results in a specific requirement for an experimental electrical, electronic, or electromechanical system/equipment. During this phase of the hardware procurement process, minimal consideration is concurrently given to the formulation of a support concept which should address significant aspects of MOTD development. MOTD-related considerations, such as the ability to maintain the system/equipment within established bounds of operational availability and support capability should impact concept feasibility decisions. However, at this juncture MOTD impact is currently limited to the recognition that as indicated in NAVELEX Instruction 5600.7, "All NAVELEX cognizant electronic equipment and systems shall be supported by technical manuals acquired, funded, and issued under the direction of the Commander, Naval Electronic Systems Command, with NAVELEX 490 as the Technical Manual Manager."

Validation Phase: Develop MOTD Requirements, Establish MOTD Criteria, and Perform MOTD Tradeoff Study - Once a concept is approved and a decision is made to procure a system/equipment, all MOTD responsibilities are assumed by the NAVELEX Technical Manual Manager (TMM). MOTD requirements are established by the TMM operating in conjunction with the Integrated Logistic Support (ILS) Manager and the Acquisition Manager. The TMM, assisted by an outside service contractor, then develops the MOTD acquisition control vehicles in the form of a Technical Manual Contract Requirement (TMCR), a Contracts Data Requirements List (CDRL), Statement of Work (SOW), and Data Item Description (DID). The MOTD acquisition control vehicles are transmitted to the ILS Manager for incorporation as one of the ILS elements into the system/equipment RFP. The TMM and service contractor perform a technical review of the various contractor responses to the MOTD portion of the RFP, but do not review the cost proposals unless requested to do so by the Acquisition Manager. A problem inherent in this process is that all support program decisions

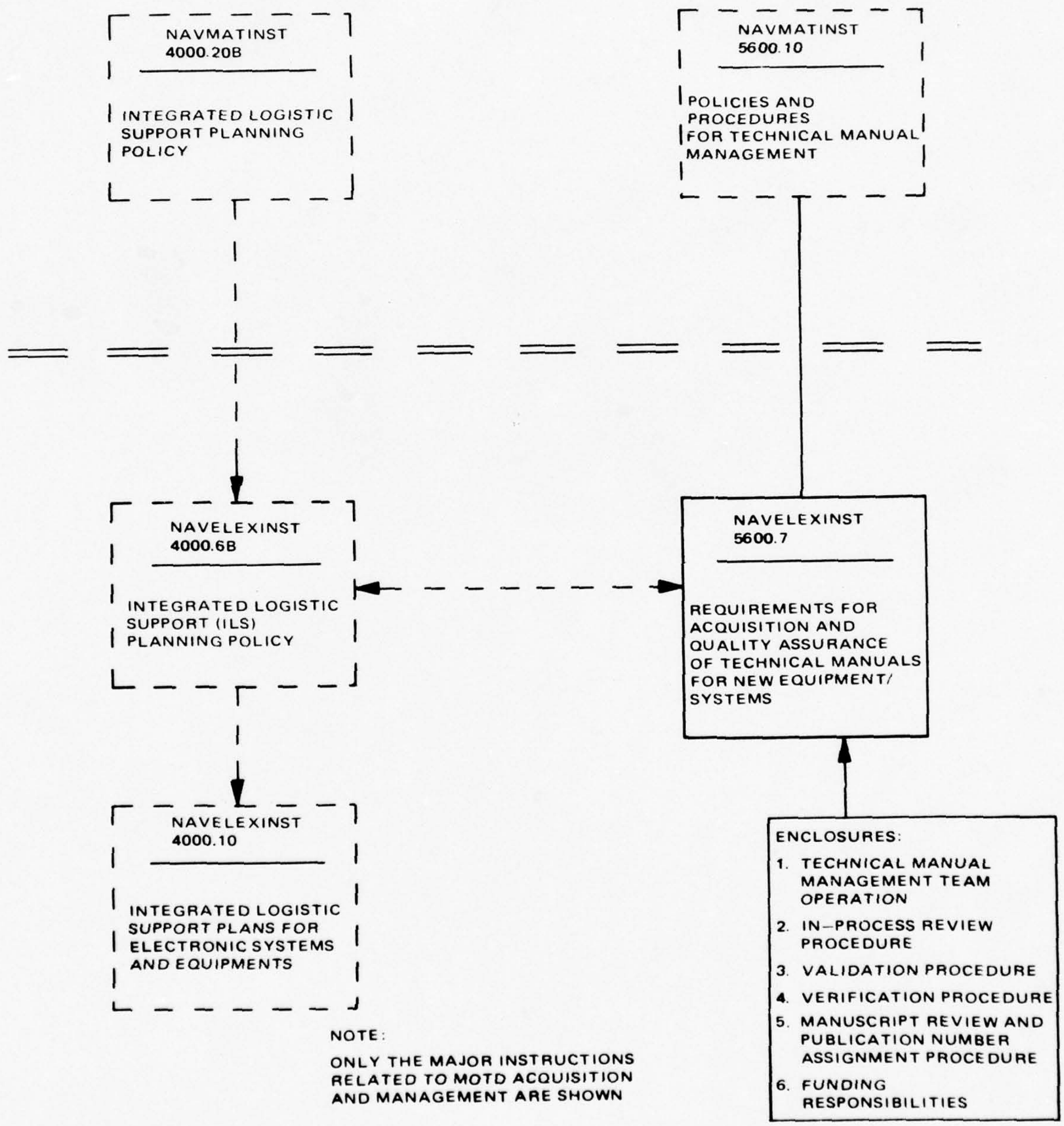

Figure 3-59. NAVELEX MOTD Management and Related Instructions for the Acquisition, Development, Quality Assurance and Delivery of NAVSEA Cognizant MOTD

(including requirements for MOTD and training) must necessarily be reactive to determinations made during hardware concept formulation which assumed the existence of an essentially unbounded support capability.

Full-Scale Development Phase: Review Contractor MOTD Plans and Schedules, Perform In-Process Review, and Receive Preliminary MOTD - Immediately after system/equipment contract award, a Technical Manual Management Team (TMMT) is established for system/equipment acquisitions of significant criticality and complexity. The TMMT is staffed by the Acquisition Manager, Project Management Engineer, Technical Manual Manager, and service contractor personnel. During this phase of the hardware procurement process, the TMMT conducts guidance conferences to provide direction to the preparing activity (contractor). Contractor Publication Plans are reviewed for completeness, adequacy, and adherence to specifications while schedules are reviewed to assure that MOTD availability is consistent with training requirements and hardware delivery schedules.

Production Phase: Initiate Formal MOTD Preparation, Perform In-Process Review, Receive Final MOTD, and Perform Update Cycle Activities - During the production phase of the system/equipment procurement process, the TMMT conducts contractor in-process reviews in accordance with the in-process review procedures of NAVELEXINST 5600.7. Accuracy of MOTD is evaluated to ensure that it provides the technical information necessary for the operation, maintenance, and training support of the system/equipment, and that it is in consonance with the maintenance concept and conformance with the specifications. However, this evaluation appears to be highly subjective in nature in that no objective criteria for evaluation are evident in the NAVELEX documentation. Additionally, the TMMT assures that the MOTD has been validated by the contractor and verified by fleet personnel prior to recommending full approval of systems and equipments for service use. There is no indication in the NAVELEX guidelines as to criteria for selection of fleet personnel for verification (supervising personnel versus actual maintenance technicians).

Support Phase: Establish Distribution Requirements and Monitor Feedback - During the support phase of the system/equipment procurement process, NAVELEX coordinates printing and distribution of MOTD with the Navy Publications and Printing Service (NPPS) and the Navy Publications and Forms Center (NPFC). Additionally, NAVELEX modifies MOTD to reflect hardware changes or to correct deficiencies that are not hardware-related. NAVELEX uses data houses to generate MOTD revisions for out-of-production equipment. MOTD revisions for in-production equipment are procured from the original equipment contractor.

3.9.9 EVALUATION OF ARMY MOTD INTEGRATION FUNCTIONS

The Army Equipment Publication Progression through the Weapons System Procurement Process closely tracks many MOTD considerations which must be addressed for adequate and usable manuals. Problems are most acute in the coordination of maintenance philosophies among publications, training, provisioning, and user personnel, and effective utilization of Logistics Support Analysis (LSA) elements in the development of their products during the various phases of the acquisition cycle.

Concept Formulation Phase: Establish MOTD Concepts, Revise MOTD Concepts, and Develop MOTD Plan - The first action associated with the development and fielding of a new Army Weapon System is the identification of a military need. This can be a requirement to combat either an existing or a projected threat, and can be either offensive or defensive in nature. Once a need is identified, an operational capability objective (OCO) is developed. The OCO is developed by the Training and Doctrine Command (TRADOC) or the Concepts and Analysis Agency. The OCO is a description of a desired operational capability for which the technical feasibility has not been proven. Additionally, any particular logistic support concepts envisioned are identified for future study.

The OCO, having been established, is then reviewed, analyzed, and transformed into a proposed development plan. During this process, each element of logistic support is studied to identify alternative support possibilities, peculiar requirements, and support costs involved with each alternative under consideration. Through tradeoff analysis unfeasible, unaffordable, and unsupportable concepts are eliminated from consideration until the best technical approach or approaches are identified. For these approaches, a maintenance concept is identified, and requirements are established for personnel, training, training device test equipment, tools, general equipment publications, provisioning, facilities, and transportation. To accomplish this, logistic studies are performed to ensure that the weapon system to be developed can be maintained and supported in the field. The technique employed to establish and/or project these logistic requirements is termed Logistic Support Analysis (LSA).

Validation Phase: Develop MOTD Requirements, Establish MOTD Criteria, and Perform MOTD Tradeoff Study - During the validation phase, preliminary design concepts are verified, planning is accomplished to resolve or minimize developmental risks, and the formal requirement documents are prepared that will be the basis for full-scale development. The design of the advanced development prototypes proceeds with logistic considerations influencing the design through the logistic support analysis (LSA) process. Problems identified during the LSA are relayed to design engineering for possible correction or minimization of adverse effects. The logistic support requirements are documented in the Logistic Support Analysis Record (LSAR). The overall maintenance concept is now transformed into a maintenance plan, based on prototype design. This maintenance plan is usually documented in the form of a preliminary maintenance allocation chart (PMAC).

Full-Scale Development Phase: Review Contractor MOTD Plans and Schedules, Perform In-Process Review, and Receive Preliminary MOTD - The first task in the production phase is the preparation of the request for proposal (RFP) and award of the engineering development contract. All contractual agreements are evaluated to ensure that all support considerations are adequately addressed.

Logistic Support Analysis is continued and updated through level of repair determinations, task analysis, logistic modeling exercise, and maintenance evaluations. During this time, there is a continuous interaction between contractor and government logistic personnel. This interaction is accomplished through logistic review teams that provide guidance to the contractor. The logistic support analysis record, draft equipment publications, support equipment lists, and reliability reports are reviewed for completeness, accuracy and usability so as to correct support problems before the end item is released to the field.

Production Phase: Initiate Formal MOTD Preparation, Perform In-Process Review, Receive Final MOTD, and Perform Update Cycle Activities - At the end of the review by Army System Acquisition Review Council/Defense System Acquisition Review Council, a full-scale production contract would be awarded. For end items classified "limited production," a Low-Rate Initial Production contract would be awarded, during which deficiencies that were identified in the draft equipment publications during the full-scale development phases are corrected.

Logistic Support Analysis (LSA) and Logistic Support Analysis Records (LSAR) documentation is continued during this phase as design changes are made in the equipment. It is through the requirements of these products, mostly the Maintenance Allocation Chart (MAC), that changes to the draft equipment publications are defined.

In actual practice, coordination between training, publications, and provisioning activities to develop or change their products with changes in Army maintenance philosophy and the MAC are somewhat disjointed.

Contractor validation and verification plans are submitted and reviewed by civilian personnel assigned by the cognizant Army procuring command. Their participation in contractor validation may or may not be funded. When the contract specifies joint validation/verification, Army review personnel are involved. More often than not, coordination and participation by representatives of training and user commands are not involved in the validation/verification effort.

In many instances, more in-process reviews (IPRs) are scheduled than ever take place. Funds are quite often not available for the review activities, or the IPRs are greatly abbreviated from what was originally planned. IPRs are not as well structured as they should be, and in many instances the reviewer gets to look only at whatever the contractor has available at that time.

Support Phase: Establish Distribution Requirements, and Monitor Feedback - As described in AR 310-2, there are three types of Army publications which receive distribution: (1) Department of the Army publications, which are regulations, orders, and instructions for the administration and operation of the Army, (2) Agency publications, which are instructions and information to subordinate elements of a command activity and (3) Command publications, which are issued by a field commander to subordinate elements under his command jurisdiction.

3.9.9 EVALUATION OF ARMY MOTD INTEGRATION FUNCTIONS (Continued)

Distribution of Army publications involves two phases, initial distribution and resupply. It is the responsibility of The Adjutant General to establish policies and procedures to provide an adequate initial supply of new and revised DA publications, changes to existing publications, and new and revised blank forms to commanders of all elements of the Department of the Army.

Monitoring and effective control of feedback to Army publications is attempted by submissions of comments and suggestions on DA Form 2028, which is contained in each equipment publication.

3.9.10 EVALUATION OF AIR FORCE MOTD INTEGRATION FUNCTIONS

Under the present Air Force Technical Order System, the integrated design and development of Air Force technical orders (TOs) under the joint auspices of the AFSC and AFLC is probably better coordinated and executed that the other military services. But even with the sophistication exhibited by this system and the many checks and controls imposed during later phases of TO development, the system lacks proper front-end MOTD considerations.

Concept Formulation Phase: Establish MOTD Concepts, Refine MOTD Concepts, and Develop MOTD Plan - According to AFSCM 310-2, as part of this effort, alternate technical data concepts should be prepared and examined. Suggested items for considertion are the applicability of current technical data methods and programs, requirements for new display techniques, data preparation techniques currently in the inventory, availability for use of commercial data, new techniques which might reduce data cost, etc. Technical data tradeoffs should be conducted, and a preferred technical data concept is identified which best supports the selected system and support program.

In actual practice, little if any action directly involving technical publications occurs in the early portion of the conceptual phase. The process does not begin until formulation of a System Program Office (SPO) cadre after definite intent to acquire the weapon system is made known. The SPO cadre is usually made up of AFSC, AFLC, Air Training Command and using command representatives. A Data Management Officer (DMO) is appointed to this initial cadre, and is the focal point for all data matters. The DMO identifies all data requirements of the program, including a determination of the technical publication requirements in gross terms.

Validation Phase: Develop MOTD Requirements, Establish MOTD Criteria, and Perform MOTD Tradeoff Study - During this phase, AF contractors are tasked to identify all Development Program Manuals (DPMs) possible that will be required to support the next phase of full-scale development.

Throughout the validation phase, the contractors and the SPO update the functional baseline and prepare the allocated baseline for full-scale development. The technical data concept (still not adequately defined) is reviewed for validity, further refined, and modified to reflect those changes made in the total system and support program. Preparation of the technical data requirements portion of the RFP are made.

Full-Scale Development Phase: Review Contractor MOTD, Plans and Schedules, Perform In-Process Review, and Receive Preliminary MOTD - During this phase, contractors review and modify DPM requirements, and preliminary manuals are prepared. Publication requirements are then made compatible with operational requirements, and commercial data is reviewed.

Publication requirements are further refined and made compatible with maintenance personnel and training requirements; maintenance actions are initially identified and publication specifications are defined, prior to a SPO/PO review.

Formal publication plans are then prepared and preliminary design reviews (PDRs) of operational elements of program are made. The deployment support requirements are identified, and the publication plans are again revised prior to a review by the Technical Order Management Activity (TOMA), which may or may not be established by the SPO.

3.9.10 EVALUATION OF AIR FORCE MOTD INTEGRATION FUNCTIONS (Continued)

A gross publication outline is prepared, reviewed, and modified by other affected agencies and reviewed and approved by TOMA, along with milestone schedules and validation/verification program plans.

Publication requirements are again refined through a critical design review prior to DPM preparation.

Contractor begins preparation of DPM, in-process reviews are held, and source data is made available to Air Training Command (ATC).

Air Force monitors and witnesses contractor validation of DPM, and data is then made available for Category I (contractor with government witness) and II (government with contractor support) testing.

Production Phase: Initiate Formal MOTD Preparation, Perform In-Process Review, Receive Final MOTD, and Perform Update Cycle Activities - During this phase, which is usually under the cognizance of AFLC as opposed to AFSC for previous phases, the publication requirements are reaffirmed by TOMA and affected agencies. Publication numbers are assigned and listed in a centrally controlled numerical index and requirements table.

The Contractor begins transition of DPM to full specification publication, periodic status reports are made, and data is again made available to ATC for Type II (government conducted) training.

The Air Force establishes a configuration baseline and quantitative requirements for using command technical publications.

In-process reviews are conducted, commensurate with the complexity of the system and guidance which contractor appears to need. Many affected AF agencies may be involved in IPR, and contractor is responsible for scheduling, conduct and notification. Prepublication reviews are held at completion of reproduction copy but prior to preparation of negatives. They are conducted by TOMA at the contractor's facility and assess the contractor's conformance with style, format, and other specification requirements.

Verification of publications are accomplished in accordance with the verification plan and AFTO 00-5-1. After completion of verification, the publications are revised to reflect the verification discrepancies prior to distribution.

Air Force publications are usually accepted by the using command and deficiencies are reported to the TOMA on AFTO Form 22 system as prescribed by TO 00-5-1.

Support Phase: Establish MOTD Distribution Requirements, and Monitor Feedback - Using commands and those activities having a need for Air Force publications must have submitted quantitative requirements to OCAMA as specified in TO 00-5-2, during the previous production phase. Requirements are machine-processed, and upon completion of the publication, the requirements are forwarded to the publication agency in the form of decks of labels for distribution to the requiring activities. The prime ALC maintains a back-up stock of all technical orders. Reprints of technical orders are obtained as required to maintain the back-up stock.

After the publications are in the field, there are several ways in which they are changed or completely revised. Periodic Command Reviews (PCR) usually result in changes to the publication based on operational experience of the using activities. Also, under the reporting procedures of AFM 66-1, deficiencies may be revealed which require correction through the medium of technical order changes. Again, the AFTO Form 22 system is used to report deficiencies. Modifications generated as a result of Engineering Change Proposals (ECPs) and Material Improvement Projects (MIPs) also result in numerous changes to Air Force publications.

3.9.11 EVALUATION OF PROPOSED MOTD INTEGRATION FUNCTIONS

Investigations to date have concluded that there is virtually a complete absence of proposed MOTD integration functions for at least two reasons: (1) the issue is complex and (2) a fascination by the technical manual community centering on "presentation techniques."

At this juncture the reader will recognize that the role of integration in SFTOA is to provide the "networking" relationship of NTIPP as an entity, thereby leaving the other research issues free to investigate widely within their own functional bounds. Further, the other research issues discuss the role of "Proposed" approaches to these specific functions. Investigations to date have led to the conclusion that there is little if any written material that could be appropriately construed as being of interest to integration, and none directly applicable. Since integration encompasses the management aspects as part of its "networking" role, one can readily postulate that a number of management principles could be applied rather directly. This will be done as part of baseline design, since ideas such as "netted-minicomputer management information systems" have an approach as an intrinsic part of their structures. Inclusion of this type of management tool would merely bias the baseline design effort, and serve to distract us from the real intent of Task 1 which is to drive toward the definition of valid NTIPP requirements.

One might ask just why there is so little data available relevant to the subject of "Proposed MOTD Integration Functions." It is suspected that the answer lies somewhere within the framework of human nature. To begin with, the origin of this interest would most likely lie within the framework of those engaging in the conduct of current MOTD activities. Frequently those engaged in an activity are caught up with it, and do not recognize the conditions as being symptoms of a larger issue. Also, there is a strong desire to characterize a problem in such a fashion as to allow application of a known "management" solution that will cause the "cure." Another aspect is that of focusing effort so intensely on the definition of what the "universal" user needs to be effective and neglecting everything else. One can cause considerable (and angry) discussion by contending that the "technical manual community" (government and industry) has totally ignored the full scope of MOTD problems while dashing madly after yet one more "presentation technique" which "the man in the fleet" really needs to be effective. As proof of this contention one merely has to view the listing of some 81 "presentation techniques" and then compare this to the absence of data on building cohesive and coherent MOTD "systems." If further evidence of the lack of concern is needed, one can review some or all of the sources cited in the Bibliography, and find nothing on the determinants of MOTD that should be considered in the evaluation of the support implications during Weapons System Concept Formulation. Yet, it was previously noted that 70% of the Life Cycle Cost of a program has been obligated at DSARC I. It is possible that MOTD considerations have zero impact on this 70% of the LCC; however, it is inconceivable that all support costs have no impact. Perhaps the known support approaches (including MOTD) can accept any variety of weapons system that gets through DSARC I, but it does appear that it would be better to so conclude based on some objective evaluation, rather than to assume it as true.

The only known government-sponsored program addressing this research issue directly or indirectly is NTIPP. It is probably premature (and the contractor could be accused of bias) to assess the effectiveness of this program and to consider its worth at least until the baseline design is in the evaluation and test cycle.

SECTION 4
FEATURE ANALYSIS

Section 4 - Feature Analysis

4.1 DEFINITION AND USEFULNESS OF MOEs AND FOEs

Measures of Effectiveness (MOEs) and Features of Effectiveness (FOEs) are research tools which aid in making a choice from a group of alternatives. MOEs and FOEs will be used in establishing the preliminary baseline in Task 3, as well as in the performance and cost tradeoffs of Tasks 4 and 5.

The basic purpose of this section of this report is to set forth effectiveness criteria in preliminary form. The logic to support this approach is to ensure a tight relationship between the NTIPP requirements which are set forth in Task 2 and the effectiveness trade-offs which are conducted in Tasks 4 and 5. Completing the comparative analysis of Task 1, wherein various criteria were established to enable a comprehensive comparison, forms a basis for the compilation of criteria specifically related to effectiveness. These criteria, while in preliminary form, indicate the types of evaluation features against which these requirements will be examined in Tasks 4 and 5. To obtain as much interaction as possible, it was felt that these criteria should be presented in the first NTIPP report, thus obtaining as complete a review and understanding as possible by key SYSCOM personnel and the other Navy agencies concerned with NTIPP.

The process of selecting a baseline approach from an array of alternatives presumes the use of objective criteria for such selection. These were presented in the NTMS RFP and the subsequent Hughes proposal as Measures of Effectiveness (MOEs), each of which was a quantitative functional attribute of performance. In brief, applying the same MOE to all the alternatives in a given set enables comparative "scores" to be assigned to each alternative. This permits numerical comparison of the alternatives.

In addition, other attributes of performance exist which are not quantifiable as such but whose importance is obvious, even in qualitative form. These have been termed Features of Effectiveness (FOEs) and take their place with the MOEs as useful tools in selecting preferred alternatives. Thus, in subsequent comparisons among alternatives, MOEs represent the means for assigning quantitative performance parameters, and FOEs represent the stipulation of "yes-no" gates which any viable alternative must satisfy. For this reason, as FOEs continue to evolve, they will tend to parallel the functional requirements which are the output of SFTOA Task 2, Establishment of NTIPP Requirements. However, while the requirements of Task 2 are more general in nature, each FOE involves some specific capability or status. A ready example may be found in the area of Content Capture, where the requirement exists to handle graphics as well as text in any automated input system. The FOE in this case involves the ability to input and process graphics in such a manner as not to impede the inherent speed and volume capacities of the text processing system.

It is recognized that the application of FOEs is more judgmental than are the use of MOEs in comparison of alternatives. For this reason, where an option exists to formulate a MOE or a FOE to describe a given attribute, the MOE is preferable. Even so, FOEs offer an important contribution to baseline development by serving as a special-purpose checklist and ratification of requirements.

Those MOEs and FOEs which are recognized and documented at this time represent a preliminary list. While they will assuredly be modified and refined in subsequent tasks, with new ones potentially added and existing ones potentially discarded, the tentative MOEs and FOEs are offered to provide the reader with an indication of the trends being taken. Considered together, the MOEs and FOEs at the system and Research Issue level, as discussed in the ensuing topics within this section, represent the present approach to selecting the baseline choices from the alternatives which will be invoked in Task 3, Preliminary NTIPP System Definition and Alternative Configurations.

Along this line, it is recognized that MOEs and FOEs will necessarily be refined through their own use in Task 3, since any exercise in system engineering tends to sharpen the tool as well as to enable convergence of the design. This process of refinement will similarly continue in Tasks 4 and 5, where specific performance and cost tradeoffs are made among the alternatives and tentative preferences of Task 3. The quantitative range of MOEs will be narrowed as consideration progresses through Tasks 3-5, and FOEs will be reconsidered and restated where appropriate. Another dimension in refinement of MOEs and FOEs is the combination of presently separate MOEs or FOEs into compound measures; this would tend to simplify the methodology of comparing alternatives by reducing the number of steps, although the calculation of performance parameters would remain unchanged even though their results be incorporated into a compound measure.

An example of this case might involve the input side of Content Capture alluded to previously. One MOE may cover the inherent input rate for text and graphics, while another may address the reliability (and hence the downtime) of the machines used for text/graphic input. These could be combined into an "effective" or "average" input rate which would account both for inherent machine speed and periods of machine outage, but the basic calculations of input speed and reliability would still be necessary.

TABLE 4-I. FOEs AND MOEs AT A GLANCE

Item	Explanation
Definition of FOEs and MOEs	Derived attributes of NTIPP performance (in whole or part) which are useful in evaluating alternatives and assessing the usefulness of NTIPP design choices
Distinction Between FOEs and MOEs	MOEs are quantitatively measurable attributes of performance, whereas FOEs are qualitative attributes relatable to "yes-no" satisfaction of requirements
Intended Use of MOEs and FOEs	Serve as decision-making tools in selecting preferred or tentative baseline choices from arrays of alternatives in Task 3; remain throughout Tasks 4 and 5, as tools in performance and cost-effectiveness tradeoffs
Present Status of FOEs and MOEs	Preliminary and tentative; subject to refinement, addition and deletion throughout Tasks 3, 4, and 5; subject also to combination into smaller numbers of FOEs/MOEs

4.2 TOP-LEVEL MOEs AND FOEs FOR NTIPP

System-level FOEs and MOEs address the effectiveness of NTIPP in establishing an improved technical manual approach within the Navy, and in seeking to lower maintenance life-cycle costs by cutting technician task time. The latter, in turn, may improve equipment availability by reducing hardware downtime.

NTIPP must be assessed on the basis of improving the operation of technical manual organizations in the Navy, so as to achieve the desired product of more effective technical manuals. Since the effectiveness of the NTIPP (or any other approach to a technical manual system) is likely to be tied to the life-cycle cost implications of fleet maintenance, it is not surprising that such effectiveness is most readily expressed in terms of life-cycle cost.

As seen in Table 4-II, all of the FOEs originally stated in the Hughes proposal dealt with improvements to the technical manuals organization(s), while all of the MOEs originally proposed dealt with factors related to life-cycle maintenance costs. One MOE has been added which relates to the existing performance of technical manual organizations, and three FOEs added which relate directly to the original MOEs involving shipboard maintenance. One additional FOE is now established - that of providing consideration of wartime as well as peacetime needs, although such provision obviously adds costs which must be regarded as premiums for wartime readiness.

The four original MOEs are readily interrelated. First, the reduction of job performance errors by the maintenance technician contributes heavily to the stipulated reduction in his job performance time, hence offering potential improvements in manning levels which reduce life-cycle cost. The operational problems and complaints by the technician are also expressable in terms of his maintenance time, and hence of life-cycle costs.

The first three of the added FOEs serve to expand these original MOEs. It has been determined through the NTIPP fleet survey of technical manual users that the major constituents of the technicians' reducible maintenance time are as follows:

1. Searches for the appropriate maintenance/troubleshooting information within their manuals.
2. Searches for part or kit numbers (including all applicable nomenclature such as Federal Stock Numbers, manufacturer's part numbers, etc.), for ordering replacement parts after troubleshooting efforts had located the faulty component(s).
3. The long turnaround times currently experienced in handling technician complaints and suggestions for improved technical manuals which would simplify their tasks.
4. The absence of present means for the technician to have confidence that his technical manual configuration accurately represents the present equipment configuration (with the implication of additional maintenance time to compensate for the lack of any such correspondence).

Consequently, these items have been added as Features of Effectiveness at the system level, and must be addressed in considering NTIPP system alternatives.

The fourth additional FOE addresses the unique problems of shipboard maintenance during wartime or other emergency conditions when it is not possible to order and acquire replacement parts in sufficient time to meet operational mission requirements. Various provisions could be made to meet this need - e.g., technical manual coverage for repair and replacement below the throwaway component level which was determined by the maintenance concept, or identification of common subassemblies so that a technician could, in emergency, cannibalize a needed part from a less critical shipboard system in the interest of returning a more critical one to operation, etc.

The additional MOE is a natural outgrowth of the previous FOE involving the effectiveness of NTIPP in synchronizing existing management and cost reporting systems; it is not enough to integrate these systems so that they all "speak the same language" and operate in concert; rather, a definite measure of NTIPP effectiveness must be the degree to which the costs of future technical manual procurements can be accurately predicted through exercise of these management and cost reporting systems.

TABLE 4-II. SYSTEM-LEVEL NTIPP FOEs AND MOEs

Features of Effectiveness (FOEs)	Measures of Effectiveness (MOEs)
*Effectiveness in synchronizing existing management and cost reporting systems	*Reduce job performance time
*Effectiveness in coordinating specification developments	*Reduce job performance errors
*Effectiveness in achieving affordable application of science and technology	*Reduce life-cycle cost
Effectiveness in reducing parts-ordering efforts through inclusion of all necessary nomenclature in the technical manual and its changes	*Number of operational problems and complaints
Effectiveness in keeping shipboard TMs up to current equipment configuration	Accuracy in predictability of future technical manual procurements
Consideration of wartime as well as peacetime needs for repair and replacement actions	Reduction in technician's search time while seeking maintenance information

*FOEs and MOEs cited in Hughes NTMS Proposal; all others added

4.3 USER-DATA MATCH MOEs AND FOEs

Principal Measures of Effectiveness (MOEs) and Features of Effectiveness (FOEs), relative to the User-Data Match are cost considerations for each presentation, media, or format technique, and the suitability/effectiveness of each technique as determined by TM user observations and surveys.

The Features of Effectiveness which must be addressed regarding the user-data match are basically judgmental in nature, and therefore can only be analyzed and quantified as to their worth by means of observation and survey methods. TM presentation techniques are a good example of a FOE. The value or worth of a presentation technique cannot be easily quantified; however, through observation of users and user surveys a qualitative judgment can be made concerning whether a given technique is effective. Media and format techniques can also best be evaluated in this manner.

Measures of Effectiveness are more "concrete" in nature and can be quantified, analyzed, and objectively evaluated. Primarily, the user-data match MOEs concern the cost aspects of using different presentation techniques, media, and formats.

A few items can be classified either as a FOE or a MOE, depending on the type of analysis deemed necessary to evaluate their worth. Things such as "readability/comprehensibility" and "TM usefulness for training" can be analyzed by user surveys and observation or by test results, which in the case of readability/comprehensibility would be scores from the Fog Index, FORCAST, etc.

The MOEs and FOEs presented in Table 4-III are those which have been identified in the Hughes NTIPP proposal and as a result of the Task 1 efforts. This listing is not intended to be complete. Additional MOEs and FOEs will be identified throughout the conduct of Task 2, Establishment of NTIPP Requirements, and Task 3, Development of Preliminary NTIPP System Definition and Alternative Configurations.

TABLE 4-III. FOEs AND MOEs WHICH IMPACT THE USER-DATA MATCH

FOEs	MOEs
Presentation technique suitability	Cost aspects of using different presentation techniques
Media suitability	Cost aspects of using different media techniques
Format suitability	Cost aspects of using different format techniques
Comprehensibility of technical manual	Readability/comprehensibility of technical manual
TM usefulness for training	

4.4 DATA ACQUISITION MOEs/FOEs

The Measures of Effectiveness (MOEs) and Features of Effectiveness (FOEs) related to data acquisition are those associated with the development and implementation of TM acquisition policies and procedures and TM specifications. These MOEs and FOEs can be classified as direct and indirect items which are measures or features of how well both the military and industry perform their respective functions with regard to data acquisition.

Data acquisition is divided into two major functional elements - TM acquisition policies and procedures, and TM specifications. Each of these major elements consists of many subelements. The MOEs and FOEs shown in Table 4-IV encompass these subelements in gross terms.

A unique feature of data acquisition MOEs and FOEs is their direct and indirect nature. A direct MOE or FOE is a measurement or feature characteristic of a functional element which is quantifiable or qualifiable, independent of impacts or influences of other functional elements. An indirect MOE or FOE can be defined as a measure or feature of a functional element which can only be quantified or qualified through the application, generation, or performance of another functional element. Also, a FOE for a functional element may be a directly relatable feature, while an associated MOE is indirectly relatable to the FOE.

For example, the FOE for specifications effectiveness in describing TM content and arrangement can be viewed as a direct FOE. It is logical to assume that specifications which contain this feature will allow contractors to respond with more exactness to the specification requirements if he has precise instructions for preparing the TM material. On the other hand, the MOE associated with this FOE can only be quantified by measuring the final product, or evaluating user acceptance and utilization of the final product.

The design of paper products (manuals, specifications, policies, etc.) is, at best, a loosely structured discipline. The design of data acquisition paper is even more nebulous. The NTIPP system design concept necessitates defining functional element requirements and assessing the environmental impact these requirements may have in the world in which they are produced. The development of FOEs and MOEs as measurement tools and preliminary performance standards is a necessary part of the design concept. By recognizing the interactive nature of data acquisition FOEs and MOEs and evaluating downstream effects of requirements which are too lax or too stringent, a systematic approach will evolve for defining TM specification requirements and the policies and procedures by which TMs are acquired.

TABLE 4-IV. FOEs/MOEs OF DATA ACQUISITION

Function	Feature of Effectiveness	Measure of Effectiveness
Specifications	• Effectiveness in coordinating development - Joint use for all SYSCOMs - Uniformity in industry usage - Rapid state-of-the-art innovations	• Uniformity of TMs delivered to fleet • Specification - Attributable costs of developing and updating
	• Effectiveness in describing TM content and arrangement - Contractor ease in interpreting - Precision of instruction for preparing material - Usefulness of material - Better technical acceptance by user	• Time to locate required information • Time to prepare additional training materials • Number of times contractor needs clarification
	• Flexibility in presentation processes and medium - Convenience of use - User motivation - Better user/data/equipment match - Better user acceptance - Promote contractor development of innovative presentation techniques	
	• Effectiveness in TM Compression - Integrated art and text - Simplified construction	• Reduction in production cost for: - Writing - Art - Composition - Printing - Updating • Better quality with increase in number of errors detected

4.4 DATA ACQUISITION MOEs/FOEs (Continued)

TABLE 4-IV. FOEs/MOEs OF DATA ACQUISITION (Continued)

Function	Feature of Effectiveness	Measure of Effectiveness
Specifications (Continued)	• Responsiveness to personnel considerations - User skill and aptitude - Training requirements	• Better user reading and comprehension • Less user supervision
	• Effectiveness in relating material to be developed to user job performance tasks - Material appropriate to user skill level - Job simplification	• Decrease in cost and MTTR due to: - Decreased time to repair - Reduction in errors - Reduction in training requirements - Reduction in maintenance induced failures - Better user personnel utilization - Reduction in user experience requirements
•	• Flexibility to environmental conditions - Better response to space limitations - Better response to field use of TM - Better safety considerations	• Time to develop in wartime or peacetime environments • Longer TM shelf life
	• Completeness in equipment coverage - Commodity complexity - Maintenance characteristics - Troubleshooting characteristics	• Decrease in cost and MTTR due to: - Job matched MOTD - Accurate MOTD - Complete MOTD
TM Acquisition Policies and Procedures	• Effectiveness of coordinated development - Common focus on problem solution - Improved NAVMAT attention level - Better definition of budget requirements	• Reduction in cost for individual development • Reduction in escalating resource requirements for future • Improved cross-servicing and utilization of other DoD documentation R&D

TABLE 4-IV. FOEs/MOEs OF DATA ACQUISITION (Continued)

Function	Feature of Effectiveness	Measure of Effectiveness
TM Acquisition Policies and Procedures (Continued)	• Effectiveness in process descriptions - Uniformity in SYSCOM/industry interfaces - Uniformity in SYSTEM/industry contract processes - Uniformity in TM acquisition, quality, and maintenance programs - Uniformity in SYSCOM/fleet liaison	• Reduction in paper production processes • Reduction in time spent resolving contractual matters • Better MTTR due to recognition of fleet needs • Reduction in escalating resource requirements for future
	• Effectiveness in process execution - Uniform TM requirements determination, planning, review, validation, verification, update, printing, distribution, change procedures, and accumulation of accurate cost data	• Improved joint use of facilities and resources • Improved user feedback and response time • Faster and more accurate information to fleet • Decrease in cost and MTTR due to: - Improved TM/equipment accounting - More uniform products in fleet - Improved discrepancy reporting - Improved NPFC/NPPSO service and accounting

4.5 CONTENT GENERATION MOEs/FOEs

The design and development of effective MOTD by the content generator is a function which is characterized by the use of creative human processes. As a result, while making use of quantifiable parameters (MOEs) where possible, the design and evaluation of this function must rely chiefly on the use of qualitative functional features (FOEs).

The FOEs and MOEs applicable to TM design and MOTD generation presented in Volume II (Scope and Approach) of Hughes Aircraft Company's "Proposal for Navy Technical Manual System (NTMS)" have been modified and expanded as shown in Table 4-V. FOEs and MOEs unique to each of the six subdivisions of the Content Generation function are identified.

The extensive use of FOEs is not encouraged in research and design because their evaluation is judgmental. However, in certain areas of content generation, where the human element plays an extensive role, the application of FOEs serve as the most rigorous analytical factors available for tradeoff comparisons.

For example, the extent to which MOTD planning documents developed by the content generator are customized to a system or equipment cannot be quantified. However, this parameter is critical in the evaluation of the performance of prewriting tasks. Therefore, an objective evaluation of the guidelines and procedures developed for the design of MOTD planning documents would have to be performed by a panel of Navy and contractor experts to determine compliance with this requirement.

NTIPP research and evaluation will make use of compound Features and Measures of Effectiveness where direct relationships exist between a number of factors. An example of the application of this concept to content generation is a modification of the approach to MOTD comprehensibility proposed in NAVAIR 00-25-700: "Technical Manual Preparation Guide for Technical Writers, Editors, and Illustrators." A single compound measure of MOTD comprehensibility might be developed based on an evaluation of the four distinct parameters identified in that document:

1. Organization: The way the TM is put together in terms of access to the material and the relationship between text and graphic information (e.g., index listings per paragraph heading, and pages of graphic information per page).
2. Complexity: The complexity of the TM in terms of both how the material is put together, and how much information the maintenance technician is expected to retain at any given time (e.g., paragraphs per paragraph heading, and proceduralized sentences per overall sentence).
3. Verbal Quality: The quality of the text in terms of readability and legibility (e.g., Fog Index, Flesch Reading Ease Score).
4. Nonverbal Quality: The quality of all nontextual material in terms of clarity, accuracy, and level of detail (e.g., components per grid area, line intersections per grid area).

TABLE 4-V. FOEs AND MOEs FOR CONTENT GENERATION

Content Generation Subfunction	FOE	MOE
• Engineering/ Manufacturing/ Maintenance Data Bases	Compatibility with MOTD development process (content, accuracy, format, and schedule) Extent of content generator involvement in development process Extent of automation (use of interactive terminals) Interface between data base developers and content generator (impact on nondeliverable data base)	Responsiveness to equipment design modifications Time to correct inaccuracies
• Prewriting Tasks	Adequacy of head book tradeoff Adherence to user-data match criteria Coordination among TM, training, logistic engineering, provisioning, and design engineering Use of innovative MOTD development approaches and presentation methods for new technology systems/equipments Recognition of inappropriate MOTD specification requirements Customization of MOTD planning documents to system/equipment	Accuracy of MOTD bid (based on estimated cost vs. actual cost) Extent of MOTD redundancy among TM, training, and logistic engineering

4.5 CONTENT GENERATION MOEs/FOEs (Continued)

TABLE 4-V. FOEs AND MOEs FOR CONTENT GENERATION (Continued)

Content Generation Subfunction	FOE	MOE
• Writing Tasks	Hardware availability for development and validation of procedural data Effectiveness of writer-MOTD work package match (personnel selection) Usefulness of MOTD for training Effectiveness of content extraction process (access) Effectiveness of validation/verification Content consistency (nomenclature, terminology, presentation technique) Effectiveness of content generator interfaces with design engineering MOTD completeness	Time to perform MOTD development tasks Adherence to MOTD production schedules Timely delivery of MOTD for training Cost of preparing MOTD Time to locate required information in TM Adherence to readability/comprehensibility criteria (text and graphics) Number technical errors Number of verification comments (procedures) Number of customer review comments Number of user complaints
• Post-writing Tasks	Compilation and decimation of program historical data (cost, problems-solutions, innovative presentation techniques and management approaches) Consistency between change package and original MOTD	Time to develop MOTD updates Time to deliver updated MOTD to field Number of technical errors Number of customer comments

TABLE 4-V. FOEs AND MOEs FOR CONTENT GENERATION (Continued)

Content Generation Subfunction	FOE	MOE
		Use of original MOTD developers for updates
• TM Presentation Techniques Handbooks	Use of detailed procedures Use of examples Coverage of front-end analysis (task, environment)	Number of presentation techniques covered
• Writers' Guides for Readability and Comprehensibility (Text and Graphic)	Use of writers' training courses Use of examples Vocabulary controls (approved lists) Ability to evaluate in-process MOTD Readability/comprehensibility measurement formulas	Extent of use of automated measurement techniques

4.6 CAPTURE AND REPLICATION MOEs AND FOEs

The FOEs and MOEs of content capture and replication are expanded from those listed in the proposal, and the MOEs restructured into compound measures. Interface MOEs and FOEs are also identified among the organizations participating in content capture and replication.

Content capture and replication issues involve considerable man/machine productive processes - the typist entering data on keyboard machines and the printer making copies, page by page, on a printing press. Consequently, features and measures of effectiveness (FOEs/MOEs) will reflect the ease and speed of a given operation, the type and quantity of output, the aesthetic and measurable quality, the cost, and similar factors. These are the traditional concerns - schedule (time), quality, and cost - that are always reflected in the most important MOEs. As with the other issues, the content capture and replication issues' measures of effectiveness will have related factors combined into compound measures. For example, there would be an input rate comprised of such factors as the average speed of the operator(s), number of input devices, speed of input devices (if batch mode), system downtime, and error rate (both operator and equipment). Other compound measures along with input rate would be update rate and output rate for both text and graphics processing. Another compound measure would be cost per page (unit), by type of page (text, tabular, diagram, mechanical drawing). These include such items as cost of content capture hardware and software, labor cost, and maintenance cost. For the products of the systems, quality can be compounded under error rate, which also is a factor of input rate and other compound measures. However, error rate as a necessary separate compound measure would consist of factors of operator mistakes, machine mistakes, illegibility, and format deviations. The compound measures for the print image and nonprint image functions of replication are constructed in the same manner to relate to the functional elements of the function. This provides a few well-defined principal measures that relate closely to the functional elements of content capture and replication in place of many basic factors. However, in Table 4-VI, some of the basic factors for measurement that would be grouped to determine a compound measure are also shown.

As with the other issues, there are several normal interface patterns which have definable sets of FOEs. For example, interfaces must be structured by policies and procedures. When more than two organizations are involved, are the policies and procedures consistent between all parties to the interface, are they compatible with the mode of operation of each, and are they acceptable and usable so that the organizations can implement them?

The interface area also involves the man/machine processes in regard to the data bank concept so both FOEs and MOEs can be defined. Computer language or coding, accessibility to the data bank by users, flexibility in handling different inputs or outputs are the type of features that apply here. The data bank operation can also be measured by speed of input or output, cost of storage, meeting quality standards for legibility or format, and amount of throughput. These are typical quantitative measurements that would be grouped as compound measures.

Content capture and replication basic FOEs and MOEs related to the functional elements of the individual subsystems are shown on the attached chart along with those for interface functions. As an example of how these will be developed, consider the feature of content capture input. Input mode can be assessed as a series of yes/no features: first, whether it can handle graphics, text, or both; if graphics, is it interactive or batch; if batch, is it intelligent or image only; or, can it handle mechanical drawings as well as diagrams, and so on. Some of these overlap into other features such as flexibility (or versatility), which also pertains to the ability of the input device to interface with more than one processor, or to be capable of doing update in addition to input.

As an aid to coarse evaluation, cost per page by type for content capture, or cost per copy by media for replication, are good gross measurements. A gross feature of effectiveness such as "does it meet minimum standards" could also be applied if needed. It would at least serve to validate, to some degree, the "cost per ______" gross measurement.

4.6 CAPTURE AND REPLICATION MOEs AND FOEs (Continued)

TABLE 4-VI. CAPTURE AND REPLICATION MOEs AND FOEs

Function	Feature of Effectiveness	Measure of Effectiveness
• INTERFACES CONTENT CAPTURE • SYSCOM to SYSCOM • SYSCOMs to Contractor • SYSCOMs to other Navy (NAVMAT - NAVSUP) REPLICATION • SYSCOMs to NPPSO • SYSCOMs to Contractor • Contractor to NPPSO • NPPSO to GPO/JCP • NPPSO to User	• Policy and Procedure Standardization - Consistent, Compatible, Acceptable, Usable, Defined • Data Base (Concept) - Automation Coding, Processing method, Specification, Accessibility, Flexibility, Integrity, Communications, Standards, Technology (growth) • Specifications and Standards - Consistent, Usable, Complete, Flexibility	• COMPOUND MEASURES - Input rate, processing rate, output rate, processing cost, storage cost by type, error rate, communications cost by type • BASIC FACTORS - Volume, capacity, speed, cost, quality, time, training, hardware, software, downtime, maintenance, size, material, etc.
• CONTENT CAPTURE SYSTEMS • TEXT PROCESSING • GRAPHICS PROCESSING • OUTPUT CONVERSION	GROSS FEATURE - Meets minimum requirements • Entry, Edit, and Update Modes, flexibility, standardization, coding, training, ease of use, technology • Processing - Storage Software versatility, language, storage methods, reliability deteriorization, flexibility, technology	• GROSS MEASURE - Cost per page • COMPOUND MEASURES - Input rate, update rate, output rate, input cost, processing cost, output cost by media, storage cost by type, error rate • BASIC FACTORS - Volume, capacity, speed, cost, quality, time, hardware, software, downtime, maintenance, size, material, etc.

TABLE 4-VI. CAPTURE AND REPLICATION MOEs AND FOEs (Continued)

Function	Feature of Effectiveness	Measure of Effectiveness
	• Output - Conversion Modes, flexibility, coding, availability, ease of use, flexibility, graphic capability	
• REPLICATION • PRINT IMAGE • NONPRINT IMAGE	GROSS FEATURE - Meets minimum requirements • Imaging, Prepress, Printing, Binding (Paper Media) Modes, flexibility, ease of use, standardization, training, reliability, technology • Imaging, Conversion, Duplicating (Other Media) Modes, flexibility, versatility, standardization, training, reliability, accessibility	• GROSS MEASURE - Cost per copy by media • COMPOUND MEASURES - Make ready rate, printing rate, cost of printing, cost of conversion by type, cost of duplication by type, error rate • BASIC FACTORS - Volume, capacity, time, quality, cost, hardware, software, downtime, maintenance, material, etc.

4.7 DISTRIBUTION, FEEDBACK, AND UPDATE MOEs/FOEs

Although the functions of distribution, feedback, and update interrelate, they each possess unique FOEs and MOEs to provide the qualitative and quantitative measures for analysis and synthesis to be performed in subsequent tasks.

FOEs and MOEs for the three functions: distribution, feedback, and update are discussed below individually. Distribution and feedback tend to be interdependent, relying on a physical communications system, and therefore, at least for future applications, have similar measurable functions. Update relates to both feedback and content generation, and uses many of the same FOEs and MOEs as does the content generation issue. However, as with all FOEs and MOEs, there are basic factors present - those of time, quality, and cost.

Distribution, feedback, and update interfaces are all controlled and driven by policies, procedures, specifications, and standards. The measures of these directives, as previously discussed, are how well they are doing their job and how well the organizations involved function within the constraints. An additional set of interface factors exists in automation of management systems and in computerized processing methods. Automation lends itself to the more tightly defined hardware and software MOEs and FOEs such as previously discussed in content capture and replication issues. The interfaces and interface responses are key elements of NTIPP development. They must be carefully assessed, evaluated, and measured for maximum system effectiveness in distribution, feedback, and update as well as for the other research issues.

Specific FOEs and MOEs for Distribution are provided on the attached chart. Distribution has functional elements of storage, configuration management, and the actual distribution of data. Since each is measurable in terms of time, quality, and cost, these basic factors can be structured into sets of compound measures, such as storage cost which would include equipment, space, personnel, and perhaps even value of the stored product. Others are shown for each functional entity along with gross measures for the entire issue. Cost per volume to store, for example, is a gross measure of effectiveness. It can be derived from dividing the number of volumes stored into the total cost of warehousing and warehouse personnel for a specified period of time. It can be useful as a "rule of thumb" since it can be relatively accurate (from one time period to another), provided the functional structure remains constant. However, it is not a substitute for a good set of compound measures.

The FOEs and MOEs for feedback cover the functional elements of information gathering or reporting, communications in both directions, the analysis process, and the corrective action. Each, as shown, can be qualitatively defined in how it adheres to standards or whether or not it is responsive, and so on. Each functional element can also be quantified; for example, how fast (in hours or days) is the response of the activity performing the function or, if automated, how much does the control processing of defect reports cost?

Update shares many of its FOEs and MOEs with the Content Generation issue, previously presented. There are some that are unique to update which relate to the match of format and content to the original data, as well as the timeliness and accuracy of the change information. The latter are the more critical factors and are embodied in the compound measures (along with cost elements). Timeliness and accuracy also serve as qualitative features of effectiveness. Update FOEs and MOEs added to selected features and measures of prewriting, writing, and post-writing functional elements of content generation provide a comprehensive set for this research issue.

TABLE 4-VII. FOEs AND MOEs FOR DISTRIBUTION, FEEDBACK, AND UPDATE FUNCTIONS

Function	Features of Effectiveness	Measures of Effectiveness
• INTERFACES DISTRIBUTION • Contractor to User • NPPSO to User • NPFC to User • SYSCOMs to NPPSO • SYSCOMs to NPFC • SYSCOMs to Contractor • SYSCOMs to SYSCOMs	• Policy and Procedure Standardization Consistent/compatible/ acceptable/usable/ defined • Specifications and Standards Consistent/usable/ complete/flexibility • Automation Coding/processing method/specification/ accessibility/ flexibility/integrity/ communications/ standards/technology (growth)	
FEEDBACK • User to SYSCOMs • SYSCOMs to Contractors • SYSCOMs to SYSCOMs • SYSCOMs to NPFC		• COMPOUND MEASURES: Processing rate, input/output rate; processing cost, storage cost by type, error rate, communications cost by type.

4.7 DISTRIBUTION, FEEDBACK, AND UPDATE MOEs/FOEs (Continued)

TABLE 4-VII. FOEs AND MOEs FOR DISTRIBUTION, FEEDBACK, AND UPDATE FUNCTIONS (Continued)

Function	Features of Effectiveness	Measures of Effectiveness
UPDATE ● SYSCOMS to Contractors ● SYSCOMs to SYSCOMs ● SYSCOMs to User		● BASIC FACTORS: Volume, capacity, speed, cost, quality, time, training, hardware, software, downtime, maintenance, size, material, etc.
● DISTRIBUTION	GROSS FEATURE: Meets minimum requirements ● Storage Utilization, method, availability, responsiveness, flexibility, integrity ● Configuration Management Consistency, ease of use, standardization, reliability, availability effectiveness ● Distributing Effectiveness, availability, accessibility, technology (growth)	GROSS MEASURES: Cost per volume to store Cost per volume to distribute ● COMPOUND MEASURES: Processing by media, transportation cost, storage cost, configuration management cost, time to respond, time to distribute by media, time to access archive, error rate, reproduction cost ● BASIC FACTORS: Volume, capacity, quality, cost, hardware, software, space, maintenance, material, etc.
● FEEDBACK	GROSS FEATURE: Adheres to Policy/Procedure ● Information Gathering/ Reporting Completeness, effectiveness, accuracy, consistency, usability, reliability	GROSS MEASURES: Processing cost per defect type Processing time per defect type

TABLE 4-VII. FOEs AND MOEs FOR DISTRIBUTION, FEEDBACK, AND UPDATE FUNCTIONS (Continued)

Function	Features of Effectiveness	Measures of Effectiveness
	• Communications Accuracy, effectiveness, timeliness, responsive, standards, reliability • Analysis, Measurement, and Evaluation Accuracy, standards, reliability, consistency, usability, completeness, technology • Corrective Action Timeliness, responsiveness, effectiveness, completeness, standards, consistency	• COMPOUND MEASURES: Cost of gathering, communications cost, analysis cost, time to gather, time to process, quantity of defects per organization/product, management reporting cost • BASIC FACTORS: Volume, quality, cost, hardware, software, material, speed, time, etc. • Response Time to Acknowledge a UR • Processing Time of UR
• UPDATE		
(NOTE: FOEs and MOEs defined for Content Generation issue are applicable to this issue and should be used. The following also apply.)		
	GROSS FEATURE: Meets minimum standards • Format (Presentation Technique) Consistent, specification, standards, completeness • Content Accuracy, completeness, consistency, usability, control (configuration) • Product (Content in proper format) Delivery schedule, acceptability, ease of use	GROSS MEASURE: Cost per page for change by type • COMPOUND MEASURES: Prewriting cost, cost to write, post-writing cost, time process, writing time, response time (to hardware change), error rate • BASIC FACTORS: Delivery, cost, quality, speed, volume, etc. • Timespan for handling emergency changes • Timespan for handling routine changes

4.8 INTEGRATION MOEs/FOEs

The MOEs and FOEs developed for Integration recognize the inherent dependence of NTIPP on the Weapons System Procurement Process and the need to ensure a logical meshing of MOTD events responsive to that process.

Since the research issue of Integration encompasses NTIPP as an entity and provides the networking relationships between the functional areas being investigated by the research issues, some degree of overlap is inevitable. There are three distinct entities which constrain NTIPP as a "system": (1) the Weapons System Procurement Process, (2) the realities of the user community, and (3) the fact that MOTD must be created from the engineering data base. To minimize repetition, the FOEs and MOEs associated with the User-Data Match and the Content Generator research issues will serve to cover the last two constraining entities.

For purposes of this discussion, the Integration FOEs and MOEs will center largely on those associated with the phases of the Weapons System Procurement Process and with the "management" FOEs and MOEs groups in the last block of Table 4-VIII. Generally, the MOEs are more determinate the closer one gets to "actuals" in the form of final MOTD. It must be realized that the MOEs are in reality basic estimating tools during the stages of Concept Formulation for a Weapons System. Features of Effectiveness also change character in a similar manner. In the early stages, the FOEs and the related Integration Criteria serve primarily as a checklist to avoid overlooking a significant aspect of MOTD procurement. In the later stages, FOEs take on a greater depth and can be more readily assessed either directly or indirectly with more definitive MOEs.

The FOEs and MOEs relating to the Intra-NTIPP activities and controls have been intentionally left at a general level. It is felt that these evaluation tools will be best developed in consonance with the baseline and alternative approaches. Since this subfunction is often characterized by the word "management" and the "management" subfunction is designed to be reactive to the needs of a specific baseline alternative, there is little value to gain by enunciating a litany of the known management tools and techniques. The real value of these detailed "management" FOEs and MOEs lies not in the fact that they are known, but in their judicious application in baseline design.

TABLE 4-VIII. INTEGRATION FOEs AND MOEs

1. Weapons System Procurement Process

a. Concept Formulation Phase (Requirement Analysis, MOTD Planning)

FOEs	MOEs
• User-Data Match Criteria Application	• Degree of "Match" to available Navy Rate, Training, etc.
• Publication Tree Structure	• Degree of Use of "Standard" TM Products
• Consideration of NTIPP Functions in Schedule (See Integration Criteria, Topic 3.9.3)	• Degree of departure from routine TM product processing

b. Validation Phase

FOEs	MOEs
• Refine Publications Tree	• Degree of Contractor Response
• Specification Selection - User-Data Match - Update-Feedback	
• Acquisition Rules Defined	
• MOTD Criteria Selected	
• Cost data structure determined	• Evaluation of Responsive Proposed Costs

4.8 INTEGRATION MOEs/FOEs (Continued)

TABLE 4-VIII. INTEGRATION FOEs AND MOEs (Continued)

c. Full-Scale Development Phase

FOEs	MOEs
• Contractor Planning Evaluation	
• In-Process Review Evaluation	
- Cost	- Cost Measures (Incurred versus Planned)
- User-Data Match	
- Schedule	- Variance of Schedule Plan versus Actual
- Validation Process	- Degree of Compliance
- Plan for Update (if applicable)	
• Preliminary MOTD	
- Risk Analysis	
- Publication Tree Evaluation	- Page Count Compliance
- Evaluation of UDM Criteria	

d. Production Phase

FOEs	MOEs
• Analysis of Variance from Development Phase - Publication Tree Changes - UDM Changes - Schedule - Cost Bounds Established	• Degree of Change
• In-Process Review (Same as Full Scale Development)	• Tighter Bounds on - Cost - User-Data Match - Schedule - Compliance
• Final MOTD (Same as Full Scale Development - Preliminary MOTD)	• Page Count Compliance
• Update LCC files for future use	

TABLE 4-VIII. INTEGRATION FOEs AND MOEs (Continued)

e. Deployment and Support Phase

FOEs	MOEs
• Relationship of Update Activity to UR level	• UR Analysis on Selected Procurements

2. Intra-NTIPP Activities and Controls

Technology Assessment

FOEs	MOEs
• Weapon System Technology	• Anticipated changes to LCC files on TM Products
• NTIPP Related Technology	• Cost Impact to NTIPP Operation

Activity Planning and Budgeting

FOEs	MOEs
• Projected Workbook	• Manpower level
• Skill level changes	• Budgeting and Forecasts

SECTION 5
CONCLUSIONS

Section 5 - Conclusions

Two distinct types of conclusions are given here: (1) those relating to points beyond the scope of SFTOA, and (2) those involving areas in which the contractor requests specific guidance, to avoid biasing the remaining SFTOA tasks.

Recognizing that the primary purpose of Task 1 is to provide the foundation for the establishment of NTIPP design requirement constraints, care must be taken to avoid drawing conclusions which could bias the development of the subsequent baseline and alternative approaches. Yet, a number of conclusions can be drawn from Task 1 relevant to NTIPP, beyond the purview of the SFTOA Phase, as discussed in the following paragraphs.

Often, one hears that NAVAIR technical manuals are "better" than those of NAVSEA or NAVELEX. This opinion is based upon a biased evaluation which does not give consideration to the considerable differences in maintenance philosophy and approach. First, NAVAIR utilizes a very definite separation between the flight line, intermediate and NARF levels. NAVSEA and NAVELEX are effectively prohibited from utilizing this separation due to the essentially noncomparable differences between ships and aircraft as weapon platforms. Second, NAVSEA and NAVELEX must follow essentially a "repair-in-place" philosophy, using test equipment which is brought to the equipment location; NAVAIR, in essence, brings the faulty equipment to the repair shop. This critical difference obviates any meaningful comparison between the types of TM products produced by NAVAIR versus NAVSEA or NAVELEX. The comparisons simply cannot be made on any valid basis because of the basic differences in repair or maintenance philosophy.

One can conclude that the very real and considerable variations in the impacts of media demand that some form of Media Evaluation Laboratory be developed by the Navy, to avoid turning the fleet into a media evaluation lab in its own right.

Some means must be found for funding the data increment above that supported by the maintenance philosophy, yet deemed essential by the fleet users. The realities of fleet deployment, and the necessity to effect repair in an emergency (which cannot be done without data) require that this added cost be considered as part of the price that must be paid to fight a war.

Differences have been noted in the funding of the TM organizations within the SYSCOMs. Some are funded by budget processes; others are based upon Navy Industrial Funding. This is a point of technical manual cost criteria which the contractor feels NAVMAT should clarify in the interest of uniformity.

SECTION 6
RECOMMENDATIONS

Section 6 - Recommendations

Three recommendations are offered on the basis of Task 1 results, involving areas which do not risk prejudging the outcome of subsequent tasks in Phase I of NTIPP.

1. Extended Coverage of Technical Manuals - The contractor recommends that Navy consideration be given to the need for repair and replacement information below the predetermined level of replaceable items established by the maintenance philosophy for the equipment supported by a given technical manual. Although the replaceable-item level usually constitutes the limit of repair and replacement instructions, the potential unavailability of replaceable item spares under wartime or other emergency conditions raises the need for technical data to support emergency repairs to return equipment to operation in timely fashion. This extended coverage in technical manuals should be accompanied by clear warnings to the technician that repairs below the replaceable-item level are not to be attempted unless specifically authorized in such emergencies.

2. Establishment of a Media Laboratory - To adequately investigate the impacts of various media available to technical manuals, and particularly to examine the effects of medium-to-medium transfer (eg, paper to video disc or microform), the contractor recommends that the Navy establish a Media Evaluation Laboratory which would be tasked with in-depth analysis of media implications prior to implementing media-related programs in the fleet. This appears the only alternative to "after-the-fact" analysis by the fleet after implementations are made.

3. Resolution of Distinctions in TM Funding - Affordability levels are a key constraint in preliminary and subsequent baselining tasks. In view of the present distinctions in the manner by which technical manuals are funded within the SYSCOMs (some by budget processes, some by Navy Industrial Funding), it is recommended that NAVMAT guidance be provided the contractor in the interest of establishing an objective means for comparing these differing funding mechanisms in formulating affordability criteria.

APPENDIX A
GLOSSARY

Appendix A - Glossary

ABBREVIATION OR ACRONYM	FULL TERMINOLOGY
	A
ACFT	Aircraft
ACPT	Acceptance
ACN	Advance Change Notice
ADP	Automatic Data Processing
ADPREPS	Automated Document Preparation System
AFB	Air Force Base
AFHRL	Air Force Human Resources Laboratory
AFLC	Air Force Logistics Command
AFPRO	Air Force Plant Representative Office
AFSC	Air Force Systems Command
AGSP	Automated Graphic Science Program
AIA	Aerospace Industries Association
AIDUS	Automated Input and Document Update System
ALC	Air Logistics Center
APP	Advanced Procurement Plan
AR	Army Regulation (or Aeronautical Requirement)
ARI	Automated Reading Index
ARMCOM	Armament Command
ASC II	American Standard Code for Digital Text Processing
ASL	Average Sentence Length
ASSY	Assembly
ATOS	Automated Technical Order System
ATS	Administration Terminal System
AUTODIN	Automatic Digital Information Network
AUTOMN	Automation
AUTOTEC	Automated Text Composition
AVSCOM	Aviation System Command (US Army)
AWL	Average Word Length
	B
BAMAGAT	Block-A-Matic, Block-A-Gram, Block-A-Text
BITE	Built-In Test Equipment
	C
CAD	Computer Aided Design
CAM	Computer Aided Manufacture
CBL	Conceptual Baseline
CDRL	Contract Data Requirements List
CEM	Communication Electronics Meteorology
CFA	Cognizant Field Activity
CFAE	Contractor Furnished Aeronautical Equipment

ABBREVIATION OR ACRONYM	FULL TERMINOLOGY
	C (Continued)
CFE	Contractor Furnished Equipment
CG	Content Generation or Commanding General
CHK	Check
CKT	Circuit
CNET	Chief of Naval Education and Training
CNM	Chief of Naval Material
COM	Computer Output Microform
COMSAT	Commercial Satellite System
CRC	Command and Reporting Center
CRT	Cathode Ray Tube
CTA	Cognizant Technical Activity
	D
DA	Department of the Army
DAPIL	Digital Assembly Parts Identification List
DAR	Data Automation Requirements
DARCOM	Development and Readiness Command
DCAS	Defense Contract Administration Service
DCSLOG	Deputy Chief of Staff for Logistics
DDD	Direct Distance Dialing
DEP	Development Equipment Publication(s)
DID	Data Item Description
DIODS	Diagram Oriented Documentation System
DLAO	Defense Logistics Analysis Office
DMAAC	Defense Mapping Agency Aerospace Center
DMO	Data Management Officer
DMWRS	Deferred Maintenance Work Requests
DoD	Department of Defense
DPM	Development Program Manual
DR	Discrepancy Report or Deficiency Report
DRT	Distribution Requirements Table
DSARC	Defense System Acquisition Review Council
DTNSRDC	David Taylor Naval Ship Research and Development Center
	E
EBCDIC	Extended Binary Coded Decimal Interchange Code
ECN	Engineering Change Notice
ECOM	Electronic Command
ECP	Engineering Change Proposal
ED	Engineering Drawing (or Engineering Design)
ENGS	Engines

ABBREVIATION OR ACRONYM	FULL TERMINOLOGY
	E (Continued)
EPC	Editorial Processing Center
EQPT	Equipment
ETM	Extension Training Material
	F
FBL	Functional Baseline
FCB	Field Change Bulletin
FIPS	Federal Information Processing Standards
FLTSATCOM	Fleet Satellite Communications
FOE	Features of Effectiveness
FOMIS	Fleet Ordnance Maintenance Information System
FOMM	Functionally Oriented Maintenance Manuals
FORCAST	Fox, Ford, Caylor, Sticht
FPJPA	Fully Proceduralized Job Performance Aids
FPTA	Fully Proceduralized Troubleshooting Aids
	G
GAF	German Air Force
GATF	Graphic Arts Technical Foundation
GFI	Government-Furnished Information
GFP	Government-Furnished Publication(s)
GPO	Government Printing Office
	H
HAC	Hughes Aircraft Company
HRMR	Human Readable/Machine Readable
HQ	Headquarters
	I
IBM	Intermediate Ballistic Missile or International Business Machines
ICBM	Intercontinental Ballistic Missile
ID	Identification
ILS	Integrated Logistic Support
ILSP	Integrated Logistic Support Plan
INSP	Inspection
INSTL	Installation

ABBREVIATION OR ACRONMY	FULL TERMINOLOGY
	I (Continued)
INTMD	Intermediate
IPB	Illustrated Parts Breakdown
IPR	In-Process Review
ITDT	Improved Technical Documentation and Training Program
	J
JCP	Joint Committee on Printing
JPA	Job Performance Aids
JPM	Job Performance Manual
	L
LCC	Life Cycle Cost
LDM	Local Digital Message Exchange
LSA	Logistic Support Analysis
LSAR	Logistic Support Analysis Record
	M
MAC	Maintenance Allocation Chart
MAINT	Maintenance
MARISAT	Maritime Mobile Satellite Communication System
MDC	Maintenance Dependency Charts
MECH	Mechanical
MIARS	Maintenance Information Automated Retrieval System
MICOM	Missile Command
MILSTRIP	Military Standard Requisition and Issue Procedures
MIP	Material Improvement Projects or Maintenance Index Pages
MNL	Manual
MMC	Maintenance Management Center
MOE	Measures of Effectiveness
MOS	Military Occupational Specialties
MOTD	Maintenance and Operating Technical Data
MPL	Maintenance Parts List
MRC	Maintenance Requirement Cards
MSLS	Missiles
MTN	Motion
MTSC	Magnetic Tape Selectric Composer
MTST	Magnetic Tape Selectric Typewriter

ABBREVIATION OR ACRONYM	FULL TERMINOLOGY
	N
NAMP	Naval Aviation Maintenance Program
NARF	Naval Air Rework Facility
NATOPS	Naval Air Training and Operator Procedures Standardization
NATSF	Naval Air Technical Services Facility
NAVAIR	Naval Air Systems Command
NAVCOMPARS	Naval Communication Processing and Routing Systems
NAVELEX	Naval Electronics System Command
NAVFAC	Naval Facilities Command
NAVMACS	Naval Modular Automated Communications Systems
NAVMAT	Naval Material Command
NAVSEA	Naval Sea Systems Command
NAVSUP	Naval Supply Systems Command
NC	Numerical Control
NMA	National Micrographics Association
NPFC	Navy Publications and Forms Center
NPPSBO	Navy Publications and Printing Services Branch Office
NPPSO	Navy Publications and Printing Services Office
NRL	Naval Research Laboratory
NSA	National Security Agency
NSDSA	Naval Sea Data Support Activity
NSF	National Science Foundation
NSWSES	Naval Ship Weapon Systems Engineering Station
NTIPP	Navy Technical Information Presentation Program
NTMMO	Navy Technical Manual Management Organization
NTMS	Navy Technical Manual System
NWC	Naval Weapons Center
	O
OCALC	Oklahoma City Air Logistics Center
OCAMA	Oklahoma City Air Material Area
OCO	Operational Capability Objective
OCR	Optical Character Recognition
OP	Operator
OPN	Operation(s)
OPNAV	Naval Operations
ORDALT	Ordnance Alteration
ORDLIS	Ordnance Logistics Information System
OVHL	Overhaul

ABBREVIATION OR ACRONYM	FULL TERMINOLOGY
	P
PCR	Periodic Command Review
PDR	Preliminary Design Review (or Preliminary Documentation Review)
PIA	Printing Industries of America
PMAC	Preliminary Maintenance Allocation Chart
PMS	Planned Maintenance System
PO	Project Office/Program Office
PPS	Percent Personal Sentences
PPT	Punched Paper Tape
PQS	Personnel Qualifications Standard
PROC	Procedure(s)
PRMIS	Printing Resources and Management Information System
PWR	Power
	Q
QRC	Quick Reaction Capability
QRTMMS	Quick Reaction Technical Manual Modification System
	R
RAC	Rapid Action Change
R&D	Research and Development
RDT&E	Research, Development, Test, and Evaluation
REM	Firm Name (REM Corporation)
REQTS	Requirements
RFP	Request for Proposal
RGL	Reading Grade Level
RIDE	Reading Impact Difficult Estimate
	S
SECAS	Ship Equipment Configuration Accounting System
SECNAVINST	Secretary of the Navy Instruction
SFTOA	Systems and Feasibility Tradeoff Analysis (Phase I of NTIPP)
SHAP	Ship Acquisition Plan
SHAPM	Ship Acquisition Project Manager
SHIPPALT	Ship Alteration
SMS	Surface Missile System
SOW	Statement of Work

ABBREVIATION OR ACRONYM	FULL TERMINOLOGY
	S (Continued)
SP	System Program Office
SRI	Stanford Research Institute
STEDMIS/STEPS	Ship Technical Data Management Information System/Ship Technical Publications System
STRL	Structural
SURTASS	Surveillance Towed Array Sensor
SYSCOM	Systems Command
	T
TACFIRE	Tactical Fire System (US Army)
TACSAT	Tactical Satellite
TCTO	Time Compliance Technical Order
TAG	The Adjutant General
TAMMS	The Army Maintenance Management System
TDI	Technical Document Index
TEC	Training Extension Courses
TLR	Top Level Requirement(s)
TLS	Top Level Specification(s)
TM	Technical Manual
TMCR	Technical Manual Contract Requirement
TMDER	Technical Manual Deficiency Evaluation Report
TMINS	Technical Manual Identification Numbering System
TMIP	Technical Manual Improvement Program
TMM	Technical Manual Manager
TMMP	Technical Manual Management Program
TMMPC	Technical Manual Management Program Council
TMMT	Technical Manual Management Team
TMP	Technical Manual Plan
TMSR	Technical Manual Ship Requirement
TMSS	Technical Manual Specifications and Standards
TO	Technical Order
TOIRS	Technical Order Improvement Reporting System
TOMA	Technical Order Management Agency
TOMS	Technical Order Microfilm System
T/R	Troubleshooting Repair
TRADOC	Training and Doctrine Command
TRUMP	Technical Review and Update of Manuals and Publications
TYMNET	Code name for a commercial data communications network between major cities

ABBREVIATION OR ACRONYM	FULL TERMINOLOGY
	U
UDM	User-Data Match
US	United States
USDA	United States Department of Agriculture
USAF	United States Air Force
USAMC	United States Army Materiel Command
USAMMC	United States Army Maintenance Management Center
USANDL	United States Army Nuclear Defense Laboratories
UR	Unsatisfactory Report
	V
VDT	Visual Display Terminal
	W
WSAP	Weapons System Acquisition Process

APPENDIX B
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